GDS

Northrop Grumman LITEF GmbH

ATTITUDE AND HEADING REFERENCE SYSTEM (AHRS)

LCR-100 PART NO. 145130-xxxx

INSTALLATION/MAINTENANCE INSTRUCTION

August 2015

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Northrop Grumman LITEF GmbH
Loerracher Strasse 18
D-79115 Freiburg i. Br.
PO Box 774
D79007 Freiburg i. Br.
Tel.: ++49 761 4901 0
Fax: ++49 761 4901 480
www.northropgrumman.litef.com

INSTALLATION/MAINTENANCE INSTRUCTION

ATTITUDE AND HEADING REFERENCE SYSTEM

LCR-100 PART No. 145130-xxxx

August 2015

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1 General

The LCR-100 **A**ttitude and **H**eading **R**eference **S**ystem **(AHRS)** is an all attitude inertial sensor system which provides aircraft attitude, heading and flight dynamics (body rates and accelerations) information, which are typically used for flight control and pilot displays.

The LCR-100 is certified to ETSO C3d, C4c, C5e, C6d and TSO C3d, C4c, C5f, C6d.

The system is mechanized as a strap down inertial measurement system using fiber optic rate sensors and micro-mechanic accelerometers which are ‘strapped down’ to the principle aircraft axes. A digital computer mathematically integrates the rate and acceleration data to obtain heading, pitch and roll attitude. Augmented by air data the system also provides filtered inertial altitude and vertical velocity.

The LCR-100 Gyrocompass versions are equipped with inertial grade instruments which enable a gyrocompassing heading alignment. After a gyrocompassing the system operates in navigation mode like an Inertial Reference System (IRS) in which it provides free inertial navigation position and velocity outputs additionally to the basic AHRS functions.

The LCR-100 also provides an attitude mode in which it provides operational modes and performance of a standard AHRS (ARINC 705). In this mode magnetic heading can be aligned and augmented by a magnetic sensor unit.

If GNSS data from an external GNSS receiver are available, the LCR-100 also outputs hybrid position and velocity data with high accuracy and bandwidth. During long term GNSS outages and disturbances the hybrid data will be calculated free inertial with the defined accuracy and drift. Based on true airspeed and GNSS data input, wind direction and wind speed will be calculated.

There is also a LCR-100 variant available which uses the attitude mode only, intended to be a substitute of the Northrop Grumman LITEF GmbH LCR-92 and LCR-93 systems. This version uses an external magnetic sensor unit (MSU) for heading alignment and augmentation and does not provide gyrocompassing alignment and navigation functions.

The LCR-100 provides the data in ARINC 429 format. Optionally the attitude and heading reference data can be provided by analog interfaces (e.g. synchro interfaces).

NOTE

In case of conflict Northrop Grumman LITEF GmbH LCR-100 System Specification No. 145130-0000-312 has preference. This document may be altered by Northrop Grumman LITEF GmbH's sole discretion.

2 How important information is shown

Warnings, Caution and Notes used in this manual emphasize the following important information:

WARNING

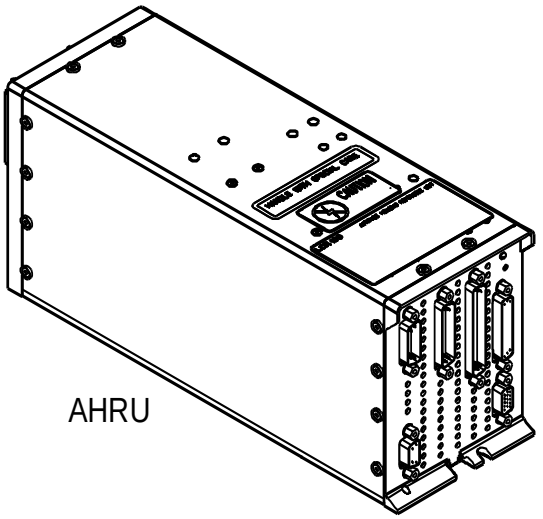
An operation or maintenance procedure, practice, condition or statement which, if not strictly observed, could result in injury or death to personnel.

CAUTION

An operation or maintenance procedure, practice, condition or statement which, if not strictly observed, could result in damage or destruction of equipment or loss of equipment effectiveness.

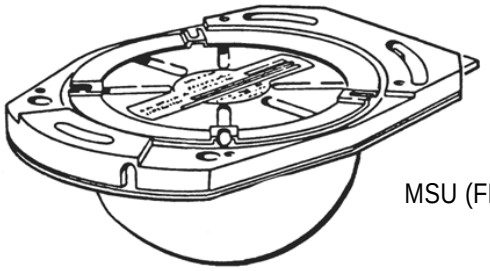
NOTE

An essential operating or maintenance procedure, condition or statement which makes the job easier or directs a user through a procedure.



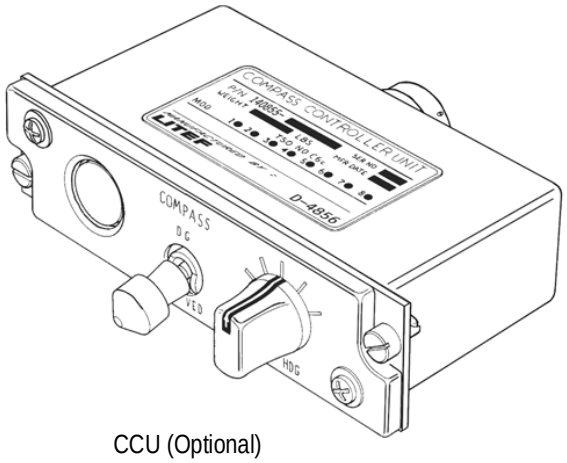
AHRU

IDM



MSU (FLUX-VALVE)

OUTLINE DRAWINGS NOT TO SCALE



CCU (Optional)

LIT00003R2

For Gyrocompass-AHRS (LCR-100 with P/N 145130-1xxx, 2-xxx and -3000): the MSU is optional.

Figure 1 LCR–100 Attitude and Heading Reference System Frontispiece
AHRU Drawing shows P/N 145130-7xxx.

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The LCR-100 Installation/Maintenance Instruction is compiled of five main sections, namely:

SECTION 1	**installation instructions**
SECTION 2	**description and operation**
SECTION 3	**initial installation & testing & trouble-shooting/ LCR-100 Maintenance Set**
SECTION 4	**removal and installation of AHRU**
SECTION 5	**storage/packaging/transportation**

Each section is divided into paragraphs and sub-paragraphs.
For a more comprehensive listing refer to the Table of contents.

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REV NO.	ISSUE DATE	DATE INSERTED	BY (1)	REV NO.	ISSUE DATE	DATE INSERTED	BY
A	Mar 2007	Mar 2007	L				
B	April 2007	April 2007	L				
C	Aug. 2007	August 2007	L				
D	Oct. 2007	October 2007	L				
E	Oct. 2008	October 2008	L				
F	July 2009	July 2009	L				
G	July 2011	July 2011	L				
H	Oct. 2012	October 2012	L				
J	July 2013	July 2013	L				
K	Aug. 2015	August 2015	L				

1) L = Northrop Grumman LITEF GmbH

RECORD OF TEMPORARY REVISIONS

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SERVICE BULLETIN LIST

SERVICE BULLETIN NO.	ISSUE	TITLE	DATE (1)
SB-LCR-100-001 (145130-0001-845)	ISSUE 1	LCR-100 Software Upgrade to MOD 18	06/11/08
SIL-LCR-100-002 (145130-0002-845)	ISSUE 1	Attitude Error after Alignment on Ground (B-290 leak tightness)	07/21/08
SIL-LCR-100-003 (145130-0003-845)	ISSUE A	Automatic Tray Misalignment Compensation with L1MS	07/28/09
SIL-LCR-100-004 (145130-0004-845)	ISSUE B	MSU Reference Fail	08/30/09
SIL-LCR-100-005 (145130-0005-845)	ISSUE A	False Inertial Magnetic Velocities output	08/18/09
SIL-LCR-100-006 (145130-0006-845)	ISSUE A	Introduction of improved LCR-100 production standard MOD 20	08/25/09
SIL-LCR-100-008 (145130-0008-845)	ISSUE A	Change of Max. Power Indication on AHRU Label	12/07/10
SIL-LCR-100-009 (145130-0009-845)	ISSUE A	LCR-100 product improvement, MOD 23	06/30/11
SB-LCR-100-010 (145130-0010-845)	ISSUE A	Program Pin Initialization after Short Power Interrupt	08/19/11
SIL-LCR-100-011 (145130-0011-845)	ISSUE A	New LCR-100 production standard MOD 24	08/31/11
SB-LCR-100-012 (145130-0012-845)	ISSUE A	Software update to repair ineffective LCR-100 MSU Compensation	04/25/12
SIL-LCR-100-013 (145130-0013-845)	ISSUE 1	Update to World Magnetic Model 2010	02/08/13
SIL-LCR-100-014 (145130-0014-845)	ISSUE A	New LCR-100 production standard MOD 25	06/20/12
SIL-LCR-100-015 (145130-0015-845)	ISSUE A	Upgrade to AHRS P/N 145130-7001	03/18/13
SIL-LCR-100-016 (145130-0016-845)	ISSUE B	LCR-100 AHRU Product Mass	05/24/13
SB-LCR-100-017 (145130-0017-845)	ISSUE D	Frozen Analog Output after Processor BITE Failures	04/01/15
SIL-LCR-100-019 (145130-0019-845)	ISSUE A	Update to World Magnetic Model 2015	04/02/15

1) American Format of Date (Month/Day/Year)

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List of Abbreviations

The following abbreviations are used in the text of this manual.

Abbreviation	Definition
A/C	Aircraft
AC	Alternating current
Accel	Acceleration
ADC	Analog Digital Converter
AF	Audio Frequency
AHRS	Attitude and Heading Reference System
AHRU	Attitude and Heading Reference Unit
AIC	Airborne Inhabited Cargo
Alt	Altitude
ARINC	AERONAUTICAL RADIO, INCORPORATED
ARW	Airborne Rotary Winged
ATA	Air Transport Association
ATT	Attitude
AUX	Auxiliary
AWG	American Wire Gauge
BCD	Binary-coded decimal
Bd	Baud
BIT	Built-In Test
BITE	Built-In Test Equipment
BNR	Binary Coded
CAL	Calibration
CalPROM	Calibration PROM
CCU	Compass Control Unit
CCW	Counter Clockwise
CDU	Control/Display Unit
Clk	Clock
CoG	Center of Gravity
CW	Clockwise
d:m:y:	day:month:year
DAC	Digital Analog Converter
DADS	Digital Air Data System
DC	Direct Current
Deg	Degrees
DG	Directional Gyro
DIS	Discrete
DITS	Digital Information Transfer System

Abbreviation	Definition
EFIS	Electrical Flight Instrument System
E/W or E-W	East/West or East-West
E²PROM	Electrical Erasable Programmable Read-Only Memory (EEPROM)
ETI	Elapsed Time Indicator
ETSO	European Technical Standard Order
FMS	Flight Management System
FOM	Figure of Merit
FPGA	Field Programmable Gate Array
ft	feet
GBAS	Ground-Based Augmentation System
GC	Gyrocompass
GmbH	Gesellschaft mit beschränkter Haftung (limited liability corporation)
GMT	Greenwich Mean Time
GND	Ground
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GPSSU	GPS Sensor Unit
HDG	Heading
HDOP	Horizontal Dilution of Precision
HFOM	Horizontal FOM
HIRF	High Intensity Radiation Field
hr	hours
hrz	horizontal
HSI	Heading Situation Indicator
HW	Hardware
Hz	Hertz
I/O	Input/Output
IDM	Installation Data Module
IEC	Index Error Correction
IFM	Interface Module
IMI	Installation/Maintenance Instruction
IMU	Inertial Measurement Unit
indic.	indicated
IRS	Inertial Reference System
kts	Knots
L1MS	Level 1 Maintenance Set
Lat	Latitude
LIHNa	LITEF Inertial Hybrid Navigator
LCR	LITEF Commercial Reference System
LOI	List of Illustrations

Abbreviation	Definition
Long	Longitude
LOT	List of Tables
LSB	Least Significant Bit
MAG	Magnetic (slaved mode)
MFD	Multi Function Display
min	minutes
MSB	Most Significant Bit
MSL	Mean Sea Level
MSU	Magnetic Sensor Unit (Flux Valve, Magnetometer)
MTBF	Mean Time Between Failure
N.C.	Normally Closed
N.O.	Normally Open
N/A	Not Applicable
N/S or N-S	North to South
NATE	Normal Acceleration Test Enable
NAV	Navigation
NCD	No Computed Data
nm	Nautical mile
NOAA	National Oceanic & Atmospheric Administration
Norm.	Normal
NV RAM	Non Volatile Random Access Memory
P/N	Part Number
PBIT	Power up BIT
PC	Personal Computer
PDOP	Position Dilution of Precision
PIC	Programmable Interrupt Controller
PM	Processor Module
PROM	Programmable Read Only Memory
PSM	Power Supply Module
PW	Power
PWR	Power
RAIM	Receiver Autonomous Integrity Monitoring
RAM	Random Access Memory
REF	Reference
REV	Revision
RF	Radio Frequency
RMI	Radio Magnetic Indicator
RMS	Root Mean Square
s	shielded
SAV	Standard Applied Voltage
SB	Service Bulletin

Abbreviation	Definition
SBAS	Satellite-Based Augmentation System
SBL	Service Bulletin List
SDI	Source Destination Identifier (ARINC 429)
sec.	second
SF	Scale Factor
SGS	Standard Ground Signal
SIG	Signal
SIL	Service Information Letter
SIM	Synchro Interface Module
SP	Service Pack
spd	speed
SPI	Short Power Interrupt
SRAM	Static Random Access Memory
SSM	Sign Status Matrix (ARINC 429)
TAS	True Airspeed
tbd	to be defined
Tk	Track
TOC	Table of Contents
TP	Title Page
ts	twisted and shielded
TST	Test
TTL	Transistor-Transistor Logic
UTC	Universal Time Coordinates (GMT)
VAC	Volts A/C Current
VDC	Volts-Direct Current
VDOP	Vertical Dilution of Precision
vert	vertical
VRTN	Volt Return
WMM	World Magnetic Model
YR	Yaw Rate

SECTION 1

INSTALLATION INSTRUCTIONS

1 Installation Data and General Information

This section contains information that will aid in the installation of the Attitude and Heading Reference System.

1.1 Configurations Overview

The LCR-100 Attitude and Heading Reference System (AHRS) consist of:

- Attitude and Heading Reference Unit (AHRU)
- Installation Data Module (IDM)
- Magnetic Sensor Unit (MSU) (optional)
- Mounting Tray (optionally with cooling fan)

1.1.1 AHRU Versions Overview

The following AHRU variants are available and can be arranged to a system:

Feature		Main Functions			Supplem. HW Modul		Customer Specific Features												
Version P/N 145130-		Standard AHRS functions	Gyrocompass and navigation	Hybrid Navigator (LIHNa)	Synchro IF 200 mV/deg AC output	Synchro IF 167 mV/deg AC output	IRS and hybrid Labels removed from output bus. Alignment process indicator on magnetic heading.	Label 215 passed through from DADS input to AHRS output. Turn Rate also output on Label 040	Data Latency of Accels and Rates reduced to < 22 ms	Hybrid data on inertial Labels	Attitude mode annunciator discrete	DG-mode annunciator discrete	GNSS Interface ARINC 743A	Accels filtered with 3Hz / Speeds with 8 Hz 2nd order low pass filter	In NAV Mode Label 270 bit 13 set to 1 and bit 14 accord. DG/MAC	GNSS Interface ARINC 743	Connector J1 Pin 5: 28 VDC ref. for SGS discrete Pin 13: GND ref. for SAV discrete	Connector J1 Pin 13: 28 VDC ref. for SGS discrete Pin 5: GND ref. for SAV discrete	Service Bulletin 145130-0017-845 incorporated
Gyrocom-pass AHRU	-1000	X	X								X		X				X		
	-1001	X	X				X				X		X				X		
	-1002	X	X							X	X		X				X		
	-1003	X	X								X					X	X		
	-1004	X	X						X		X		X				X		
	-1005	X	X							X	X		X	X			X		
	-1006	X	X								X		X		X		X		
	-2000	X	X		X						X		X				X		
	-2001	X	X		X						X		X		X		X		
	-2010	X	X		X						X		X				X		X
	-2011	X	X		X						X		X		X		X		X
	-3000	X	X	X							X		X		X		X		
Standard AHRU	-6000	X									X						X		
	-6001	X						X			X						X		
	-6002	X										X					X		
	-6200	X										X						X	
	-7000	X			X						X						X		
	-7001	X			X							X					X		
	-7010	X			X						X						X		X
	-7011	X			X							X					X		X
	-7100	X				X						X					X		
	-7110	X				X						X					X		X

Table 1-1 AHRU Versions

1.1.2 Installation Data Module (IDM) Overview

For detailed information about IDM refer to section 2, paragraph 4.4.

The following listed IDM versions are available:

Part Number of IDM	IDM Version
124282-0000	Standard IDM
124282-2xxx	Extended IDM (1)
124282-2100	Extended IDM - Contains the WMM2010 by factory setting (1)
124282-2200	Extended IDM - Contains the WMM2015 by factory setting (1)
124282-xxxx	Customized IDM

Table 1-2 Available IDM versions

1) Usable with 145130-1XXX,- 2XXX and -3000 each with MOD25 onwards (refer to section 3, para. 6)

1.1.3 Mounting Tray Overview

For detailed information about Mounting Trays refer to section 2, paragraph 4.5.

The following listed Mounting Tray-versions are available:

Part Number of Tray	Mounting Tray Version		
145137-0100	ruggedized tray	without fan	LCR-100 type
145138-0100	ruggedized tray	with fan	LCR-100 type
145138-xxxx	Customized, ruggedized tray	with fan	LCR-100 type
124260-0000	standard tray	without fan	LCR-92/93 type
140691-0000	standard tray	with fan	LCR-92/93 type
144201-0000	ruggedized tray	without fan	LCR-92/93 type
144200-0000	ruggedized tray	with fan	LCR-92/93 type

Table 1-3 Available Mounting Trays

1.1.4 Magnetic Sensor Unit (MSU) Overview

For detailed information about MSU refer to section 2, paragraph 4.6

The following listed MSU versions are available:

Part Number of MSU	MSU Version	
450910-2362	Bendix/King KMT 112	(Bendix/King P/N 071-1052-00)
450910-3078	Honeywell FX-120	(Honeywell P/N 620359)
450910-3079	Honeywell FX-125	(Honeywell P/N 656520)
450910-3080	Honeywell FX-220	(Honeywell P/N 2594484)
450910-6895	Honeywell FX-600	(Honeywell P/N 7010133)
450910-7715	TECSTAR FV-1	(TECSTAR P/N 2961182-1)

Table 1-4 Available MSU versions

1.1.5 Installation Kit for AHRU (Connector Set)

Part Number of Inst. Kit	Installation Kit Version
P/N 145146-0000	for AHRU with Synchro Interface (LCR-100 P/N 145130-2xxx and -7xxx) (full metallic housing)
P/N 145147-0000	for AHRU without Synchro Interface (LCR-100 P/N 145130-1xxx, -3000 and -6xxx) (full metallic housing)

Table 1-5 Installation Kit versions

Figure 1-1 Installation kit 145146-0000

Pos	NG-LITEF P/N	Qty.	Nomenclature	Cage / manufacturer P/N
1	450910-0822-000	1	Receptacle, rectangular + pins (Backshell: refer to Pos. 2)	28198 / DD62F10000 or 00779 / 1-1757824-0 or 28198 / DD62S10000
2	450910-5524-000	1	Backshell, connector	C1129 / FMH4-K1073 or C1129 / UHM37-MOD.
3	450910-2008-000	1	Receptacle, rectangular + pins; (Backshell ref. to Pos. 5)	28198 / RD15F10000
4	450910-2338-000	1	Plug, rectangular + pins (Backshell: refer to Pos. 7)	28198 / DD44M10000 or 00779 / 1757823-9
5	450910-5522-000	1	Backshell, connector	C1129 / FMH2-K1073
6	450910-2704-000	8	Jackscrew	C1129 / FRS1/5M3
7	450910-5523-000	2	Backshell, connector	C1129 / FMH3-K1073
8	450910-2508-000	1	Receptacle, rectangular + pins (Backshell: refer to Pos. 7)	28198 / DD44F10000 00779 / 1757824-9

Table 1-6 Installation kit 145146-0000, Bill of material

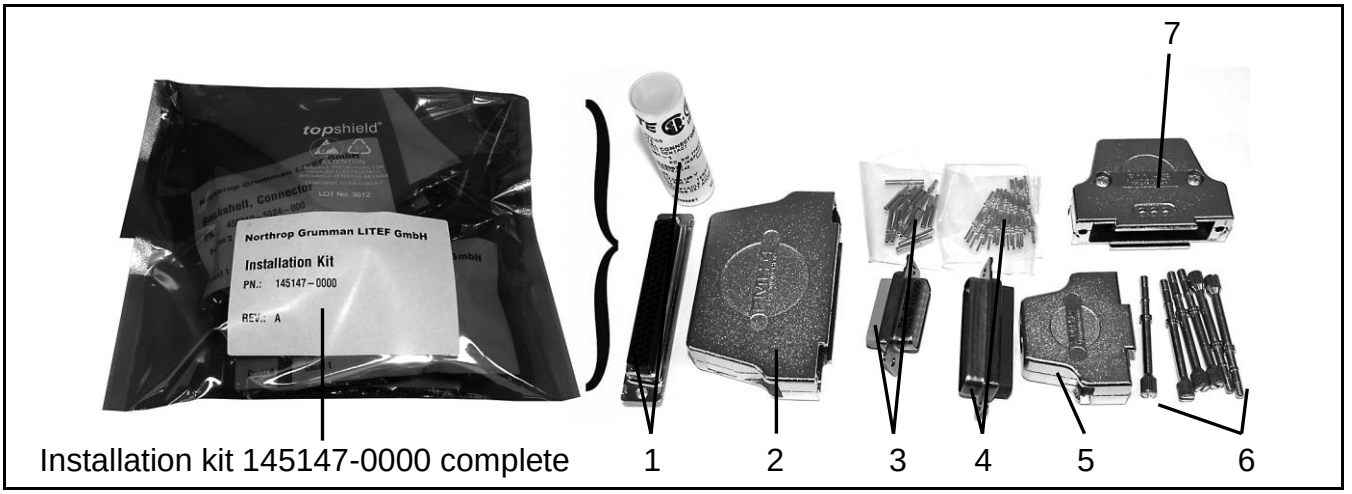


Figure 1-2 Installation kit 145147-0000

Pos	NG-LITEF P/N	Qty.	Nomenclature	Cage / manufacturer P/N
1	450910-0822-000	1	Receptacle, rectangular + pins (Backshell: refer to Pos. 2)	28198 / DD62F10000 or 00779 / 1-1757824-0 or 28198 / DD62S10000
2	450910-5524-000	1	Backshell, connector	C1129 / FMH4-K1073 or C1129 / UHM37-MOD.
3	450910-2008-000	1	Receptacle, rectangular + pins; (Backshell ref. to Pos. 5)	28198 / RD15F10000
4	450910-2338-000	1	Plug, rectangular + pins (Backshell: refer to Pos. 7)	28198 / DD44M10000 or 00779 / 1757823-9
5	450910-5522-000	1	Backshell, connector	C1129 / FMH2-K1073
6	450910-2704-000	6	Jackscrew	C1129 / FRS1/5M3
7	450910-5523-000	1	Backshell, connector	C1129 / FMH3-K1073

Table 1-7 Installation kit 145147-0000, Bill of material

1.1.6 Compass Control Unit (CCU) (optional) Overview

For detailed information about CCU refer to section 2, paragraph 4.7.1.

The following listed CCU-versions are available:

Part Number of CCU	CCU Version
140855-0010	CCU (5 V Lighting, black panel)
140855-0020	CCU (28 V Lighting, black panel)
140855-0030	CCU (5 V Lighting, grey panel)
140855-0040	CCU (28 V Lighting, grey panel)
141468-0000	Installation Kit for CCU (Connector Set) (details refer to Table 1-9)

Table 1-8 Available CCU versions

Pos	NG-LITEF P/N	Qty.	Nomenclature	Cage / manufacturer P/N
1	450905-2678-000	1	Plug, circular	MIL-C-83723 M83723-75R1415N
2	450904-6052-141	1	Backshell, connector	MIL-C-85049/52 M85049/52-1-14A

Table 1-9 CCU Installation kit 141468-0000, Bill of material

1.1.7 Level 1 Maintenance Set (L1MS)

For detailed information about L1MS refer to section 3, paragraph 2.

The following listed L1MS are available:

Part Number of L1MS	L1MS Version
309946-0000	**LCR-100 L1MS Base Version** (for all LCR-100 Versions to determine Pitch & Roll compensation data)
309946-0500	**LCR-100 L1MS Base Version + Gyrocompass Tool option** (for all LCR-100 Versions to determine Pitch & Roll compensation data) + (for LCR-100 Gyrocompass AHRS (P/N 145130-1xxx, -2xxx and -3000) to determine Pitch, Roll and Heading compensation data)
309946-0100	**L1MS Base Version** (for all LCR-100 Versions to determine Pitch & Roll compensation data)
309946-0501	**L1MS Base Version + Gyrocompass Tool option** (for all LCR-100 Versions to determine Pitch & Roll compensation data) + (for LCR-100 Gyrocompass AHRS (P/N 145130-1xxx, -2xxx and -3000) to determine Pitch, Roll and Heading compensation data)

Table 1-10 Available L1MS versions

1.2 Correlation MOD Status to System Software Version

MOD Status	System Software Version	MOD Status	System Software Version
MOD 12	System SW 1100	MOD 23	System SW 1600
MOD 16	System SW 1200	MOD 24	System SW 1700
MOD 18	System SW 1300	MOD 25	System SW 1800
MOD 19	System SW 1400	MOD 26	System SW 1900
MOD 20	System SW 1500	MOD 27	System SW 1900
MOD 22	System SW 1500		

Table 1-11 Correlation AHRU MOD Status to Software Version

1.3 Weights

AHRS - Component	Weight
AHRU	
- with synchro interface (LCR-100 P/N 145130-2xxx and -7xxx)	less than 3.00 kg
- without synchro interface (LCR-100 P/N 145130-1xxx; -3000 and -6xxx)	less than 2.72 kg
MSU	
- KMT112 (P/N 450910-2362)	0.136 kg
- FX-120 (P/N 450910-3078)	0.680 kg
- FX-125 (P/N 450910-3079)	0.680 kg
- FX-220 (P/N 450910-3080)	0.680 kg
- FX-600 (P/N 450910-6895)	0.680 kg
- FV-1 (P/N 450910-7715)	0.680 kg
CCU (P/N 140855-0010, -0020, -0030 or -0040)	0.40 kg max
Mounting Tray LCR-100	
- without fan (P/N 145137-0100)	less than 0.55 kg
- with fan (P/N 145138-0100)	less than 0.67 kg
Mounting Tray LCR-92/93 standard	
- without fan (P/N 124260-0000)	less than 0.35 kg
- with fan (P/N 140691-0000)	less than 0.50 kg
Mounting Tray LCR-92/93 ruggedized	
- without fan (P/N 144201-0000)	less than 0.50 kg
- with fan (P/N 144200-0000)	less than 0.65 kg
IDM (P/N 124282-0000; -2xxx or -xxxx)	less than 0.035 kg

Table 1-12 Weight of AHRU and AHRS Components

1.4 Location in the A/C

The AHRU is generally located in the aircraft's equipment bay electronics rack, and its major axes must be parallel or perpendicular to the major axes of the aircraft. The CCU is installed on a panel in the cockpit. The MSU should be located as far away as possible from all sources of local magnetic disturbances such as engines, electrical cables or radio equipment. A wing tip or tail section location will usually be satisfactory.

1.5 Power

The **AHRU Power** is designed to operate from either a primary or an auxiliary 28 VDC power input. Both power inputs are intended to be supplied by different electrical busses and can be powered at the same time without impact on the system and the aircraft power supply. The system switches on when the voltage exceeds 18 VDC. The system operates with an input voltage down to 15 VDC.

The power consumption of the AHRU is listed below. The maximum power consumption of the optional cooling fan is less than 3 Watts (which is not included in Table 1-13 below).

Configuration	Power Consumption	
	nominal	maximum
AHRU without Synchro Interface (LCR-100 P/N 145130-1xxx, -3000 and -6xxx)	26 W	30 W
AHRU with Synchro Interface (LCR-100 P/N 145130-2xxx and -7xxx)	40 W	45 W

Table 1-13 Power Consumption

The AHRU System Power:

The AHRU provides the following System power:

System power	Value
Cooling fan power	+ 24 VDC
CCU power	+ 28 VDC
Magnetometer power	+ 28 VDC
Reference signal for SGS discretes	+ 28 VDC
Flux valve excitation	10.8 - 40 VRMS, 400 Hz

Table 1-14 System Power provided by AHRU

The inrush current of the system is limited to 14A. An inrush current peak with duration of max. 4 ms may occur.

CAUTION

These outputs may not be used for other than the intended purpose without the written consent of Northrop Grumman LITEF GmbH engineering department.

1.6 Connectors

The AHRU external connectors are Sub-Min-D type with metric M3 screw locks and have the following pin complements:

Connector	Function	Pins/Sockets	Connector type
J1	Power Supply	15 p	M24308/4-2
J2	Fan Supply	9 s	not required (1)
J3	Synchro Interfaces (2)	44 p	M24308/4-13
J4	Input/Output	62 p	M24308/4-14
J5	IDM	15 s	not required (1)
J6	Input/Output and Test	44 s	M24308/2-13 (3)

Table 1-15 Connectors Configuration

1) No wiring is required for connector J2 (Fan Supply) and for connector J5 (IDM) because the mating connectors are integral parts of the Mounting Tray with Fan and the IDM itself. If no Fan is used, we recommend to cover connector J2 as described in section 1, para. 9.10.3, sub-para "Unused AHRU connectors". The metal block attached to the end of the IDM retaining cable should be permanently affixed to the Mounting Tray with the two machine screws provided.
2) Synchro Connector 1J3 is only available for systems with installed synchro interface module (LCR-100 P/N 145130-2xxx and -7xxx)
3) If connector J6 is not used, we recommend to cover it as described in section 1, para. 9.10.3, sub-para "Unused AHRU connectors"

The mating connectors with metric (M3) screw lock shall have metal or metallized plastic backshells.

The MSU connector is 030-2189-00 for the KMT 112 flux valve.

The CCU connector is M83723/72R1415N.

1.7 Bonding

The bonding resistance between the AHRU and the aircraft structure shall be less than 5.0E-3 Ohm, measured between the front part of the AHRU (e.g. connector) and the aircraft structure.

If the 5.0E-3 Ohm cannot be achieved (due to high impedance between tray and A/C structure) a bonding strap from the tray to the A/C shall be attached.

1.8 Insulation Resistance

The insulation resistance measured between all electrical circuits and the metallic case shall be at least 20 MOhm.

2 Wiring

Wiring details are provided in paragraph 9 at the end of this section.

3 Program Pins and Other Discretes

3.1 Program Pins

The following 13 AHRU connector pins are allocated for external program control:

Pin	Function
J4-32	Program Pin Common
J4-14	Mounting Position No. 1
J4-35	Mounting Position No. 2
J4-34	SDI 1
J4-54	SDI 2
J4-12	DG Mode Logic Select
J4-1	Ground/Air Logic Select
J4-17	ARINC Turn Rate Select
J4-53	Yaw Rate Scale Factor Select No. 1
J4-11	Yaw Rate Scale Factor Select No. 2
J4-23	MSU Excitation Voltage Select
J4-44	ARINC Update Rate Select
J4-43	Parity (odd)

For detailed information about the Program Pins refer to section 1, paragraph 4.2.1.2.

3.2 Control Discretes

For the description of the Control Discretes refer to section 1, paragraph 4.2.1.3.

3.3 Mode- and failure reset button and LED indication

Depending on the system state the mode button can be either used to enter the MSU calibration mode or to reset a failure. The red LED indicator and the mode button are located on the front plate (refer to Figure 1-9).

There are three possible indication statuses:

- LED is not illuminated: AHRU is switched off or it is in normal operation mode)
- LED flashes: indicates a failure
- LED is illuminated continuously: (AHRU operates in MSU calibration mode)

To avoid inadvertent operation it is only possible to activate the mode button using a pointed tool.

LED as fault indicator

In case of a detected fault, the fault indicator flashes once a second. If the fault is caused on A/C side (e.g. wiring, electrical or digital interface) and not on the AHRU itself, the fault indicator can be reset by pressing the mode button for minimum 2 seconds. Than the LED flashes 10 times at a higher rate as the fault indicator before. If reset is successful the fault indicator extinguishes and the failure is not present any more.

NOTE

As long as the fault indicator is set active the MSU calibration mode cannot be entered by using the mode button.

Detailed description of fault indicator and troubleshooting procedures: refer to section 3, paragraph 4.3.2

LED as MSU calibration mode indicator

The MSU calibration mode can be activated by the MSU calibration discrete or by pressing the mode button for minimum 2 seconds if:

- the AHRU is in normal operation mode (alignment completed) and
- the A/C is determined to be on ground (ground/air discrete is set to A/C on ground) and
- a MSU is detected at power on and
- no motion is detected

If MSU calibration mode is active the LED is illuminated continuously.

Detailed description of MSU calibration mode: refer to section 2, paragraph 5.5

4 Interfaces

Interface Diagram	refer to section 1, paragraph 4.1
Discrete Interfaces	refer to section 1, paragraph 4.2
Digital Interfaces	refer to section 1, paragraph 4.3
Analog Interfaces	refer to section 1, paragraph 4.4
MSU (Flux Valve) Interface	refer to section 1, paragraph 4.5
Test Interfaces	refer to section 1, paragraph 4.6

4.1 Interface Diagram

Figure 1-3 shows the interface diagram of the LCR-100 with embedded optional synchro interface module.

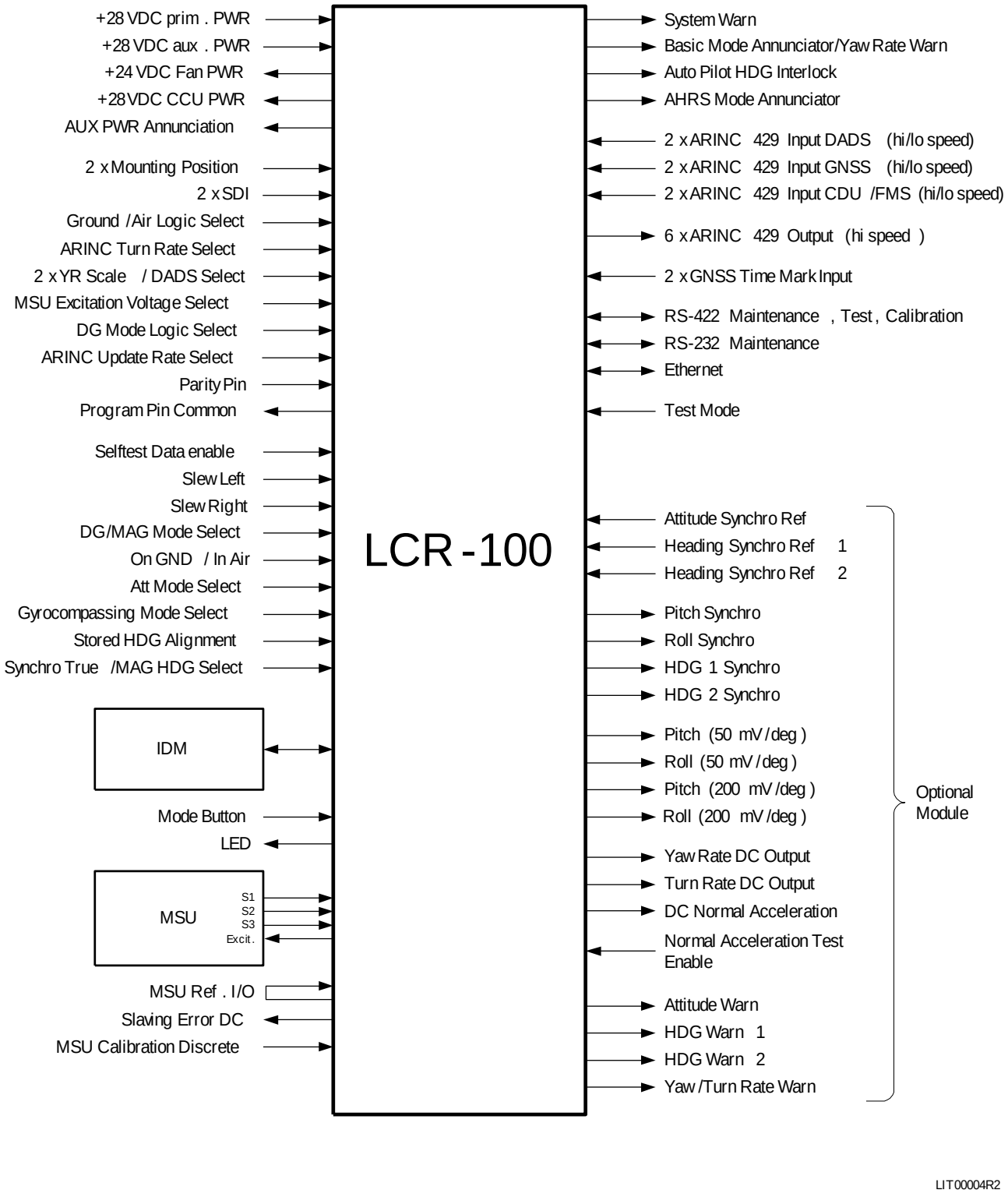


Figure 1-3 Principal Interface Block Diagram of the LCR-100

4.2 Discrete Interfaces

4.2.1 Discrete Input

4.2.1.1 General

The electrical and logic characteristic of the SAV and SGS discretes are shown in Table 1-16.

Discrete Type	Active	Not Active
Standard Applied Voltage (SAV) 28 VDC/Open	Lowest operation voltage up to – 36.0 VDC	R ≥ 100 kOhm
Standard Ground Signal (SGS) GND/Open	Voltage < 3.5 VDC	R > 10 Ohm

Table 1-16 Discrete Logic

SGS discretes are referenced to + 28 VDC aircraft power. SAV discretes are referenced to 28VRTN.

4.2.1.2 Program Pins

Program Pin Common

The Program Pin Common (J4-32) provides the 28VRTN signal to set the SGS program pins.

NOTE

The ARINC Turn Rate Select Discrete is a SAV discrete; all other program pins are SGS discretes.

Mounting Position (refer to Figure 1-4)

The azimuth mounting orientation in the aircraft is identified by the Program Pins Mounting Position No. 1 and No. 2 as defined in the following table:

Program Pin	Plug Forward	Plug Aft	Plug Right Wing	Plug Left Wing
Mounting Pos. 1 (J4-14)	open	jump to common (J4-32)	open	jump to common (J4-32)
Mounting Pos. 2 (J4-35)	open	open	jump to common (J4-32)	jump to common (J4-32)

Table 1-17 Mounting Position Discretes

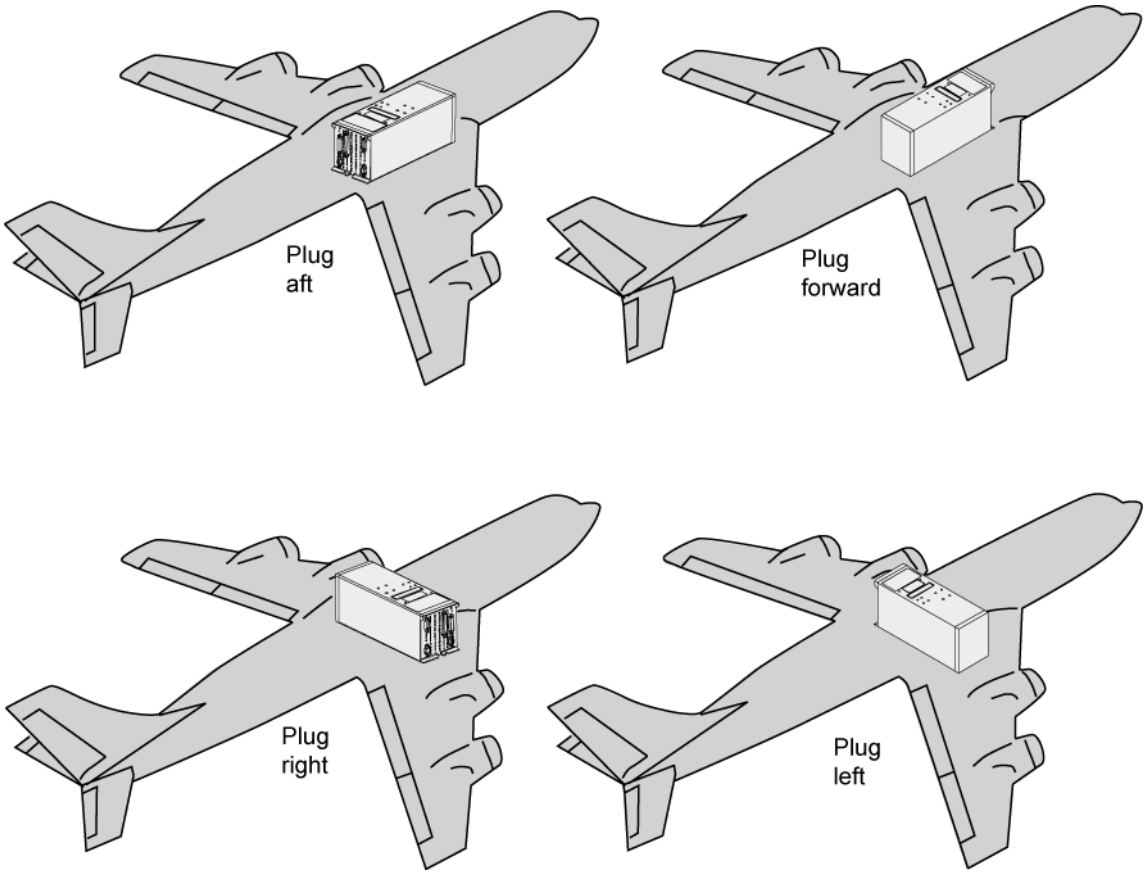


Figure 1-4 Mounting Positions of AHRU

Source Destination Identifier (SDI)

The Source Destination Identifier in the ARINC words is set by the Program Pins SDI No. 1 and No. 2 as defined in the following table. This setting is valid for:

- all ARINC outputs of the system
- ARINC input Labels 043 and 275 (only LCR-100 systems with P/N 145130-1000, -2xxx and -145130-3000)

Program Pin	N/A	System No. 1	System No. 2	System No. 3
SDI 1 (J4-34)	open	jump to common (J4-32)	open	jump to common (J4-32)
SDI 2 (J4-54)	open	open	jump to common (J4-32)	jump to common (J4-32)

Table 1-18 Source Destination Identifier

DG Mode Logic Select

The logic of the DG/MAG Mode Select discrete is configurable by the DG Mode Logic Select program pin (J4-12) as defined in the following table.

DG Mode Logic Select (J4-12)	DG/MAG Mode Select	
	28 VDC	Open
open	DG Mode	MAG Mode
jump to common (J4-32)	MAG Mode	DG Mode

Table 1-19 DG Mode Logic Select

Ground/Air Logic Select

The logic of the On Ground / In Air discrete is configurable by the Ground/Air Logic Select program pin (J4-1) as defined in the following table.

Ground/Air Logic Select (J4-1)	On Ground / In Air Discrete	
	Ground	Open
open	in Air	on Ground
jump to common (J4-32)	on Ground	in Air

Table 1-20 Ground/Air Logic Select

ARINC Turn Rate Select

The content of the ARINC Label 330 and 340 is selectable to either Turn Rate or Yaw Rate by the ARINC Turn Rate Pin (J4-17) as defined in the following table.

ARINC Turn Rate Select (J4-17)	ARINC Output Label 330	ARINC Output Label 340; Only valid for P/N 145130-1006 and -3000
open	Yaw Rate	Turn Rate
+ 28 VDC	Turn Rate	Yaw Rate

Table 1-21 ARINC Turn Rate Select

YR Scale Factor Select

The scale factor of the Yaw Rate DC output (refer to section 1, paragraph 4.4.2.3) of the synchro interface board is selectable by the Program Pins YR Scale Factor No. 1 and No. 2 as defined in the following table.

Program Pin	Analog Yaw Rate Scale Factor			
	200 mV/deg/s	100 mV/deg/s	333 mV/deg/s	666 mV/deg/s
YR Scale Factor Select 1 (J4-53)	open	open	jump to common (J4-32)	jump to common (J4-32)
YR Scale Factor Select 2 (J4-11)	open	jump to common (J4-32)	open	jump to common (J4-32)

Table 1-22 Yaw Rate Scale Factor Select

This function is only applicable for Systems with installed Synchro Interface Module (P/N 145130-2xxx and 145130-7xxx). Otherwise these pins are used as DADS select discretes.

MSU Excitation Voltage Select

The voltage of the MSU Excitation and the adequate signal processing (refer to section 1, paragraph 4.5) is selectable by the MSU Excitation Voltage Select Pin (J4-23) as defined in the following table.

MSU Excitation Voltage Select (J4-23)	MSU Excitation Voltage
open	23.5 VAC (Honeywell/Tecstar type MSU)
jump to common (J4-32)	12.5 VAC (Bendix King type MSU)

Table 1-23 MSU Excitation Voltage Select

ARINC Update Rate Select

The update rate of the ARINC Labels 040, 301, 320, 324, 325, 326, 327, 330, 331, 332, 333 and 340 is selectable by the ARINC Update Rate Select Program Pin (J4-44) as defined in the following table.

ARINC Update Rate Select (J4-44)	ARINC Update Rate
open	High Update Rate
jump to common (J4-32)	Low Update Rate

Table 1-24 ARINC Update Rate

Refer to Table 1-48 for further details.

Parity

The setting of the program pins (except the SDI Program Pins) is checked for odd parity. If a program pin is left open, it is valued to 0 (zero) otherwise to 1. The parity of the program pin setting is calculated as follows:

LCR-100 Systems with P/N 145130-1xxx, -3000 and -6xxx:

Parity =	Mounting Pos. 1 + Mounting Pos. 2	(J4-14 + J4-35)
+	DG Mode Logic Select	(J4-12)
+	Ground/Air Logic Select	(J4-1)
+	ARINC Turn Rate Select	(J4-17)
+	MSU Excitation Voltage Select	(J4-23)
+	ARINC Update Rate Select	(J4-44)
+	Parity Pin	(J4-43)

LCR-100 Systems with P/N 145130-2xxx and -7xxx (LCR-100 with installed synchro interface module)

Parity =	Mounting Pos. 1 + Mounting Pos. 2	(J4-14 + J4-35)
+	DG Mode Logic Select	(J4-12)
+	Ground/Air Logic Select	(J4-1)
+	ARINC Turn Rate Select	(J4-17)
+	YR Scale Factor 1 + YR Scale Factor 2	(J4-53 + J4-11)
+	MSU Excitation Voltage Select	(J4-23)
+	ARINC Update Rate Select	(J4-44)
+	Parity Pin	(J4-43)

To avoid a parity warning the result of the parity calculation (including parity pin) has to be odd (e.g. if the parity result without parity pin is even, the parity pin has to be jumped to common; if the result is odd, the pin has to be left open).

4.2.1.3 Control Discretes

To operate the system in different modes it provides the control discretes as defined in the following table.

Control Discretes	Pin	Format	-1xxx	-2xxx	-3000	-6xxx	-7xxx	Comment
Selftest Data Enable	J4-55	SGS	x	x	x	x	x	
DG/MAG Mode Select	J4-57	SAV	x	x	x	x	x	
Slew Left	J4-16	SAV	x	x	x	x	x	
Slew Right	J4-58	SAV	x	x	x	x	x	
On Ground / in Air Discrete	J4-37	SGS	x	x	x	x	x	
DADS Select No. 1 & 2	J4-53 J4-11	SGS	x		x	x		
Attitude Mode Select	J4-04	SGS	x	x	x			
Gyrocompass Mode Select	J4-56	SGS	x	x	x			
Stored Heading Alignment	J4-52	SGS	x	x	x			
Synchro True/Mag HDG Select	J4-25	SGS		x				
MSU Calibration Discrete	J4-38	SAV	x	x	x	x	x	
Test Mode	J6-18		x	x	x	x	x	Referenced to Secondary Signal Ground
Fan Test Enable	J2-04(A) J2-05(B)		x	x	x	x	x	
Normal Acceleration Test Enable	J3-36			x			x	
Command Interface Select	J5-08	TTL	x	x	x	x	x	For lab test only
Engineering Mode Enable	J5-07	TTL	x	x	x	x	x	For lab test only

Table 1-25 Control Discretes

Selftest Data Enable

The Selftest Data Enable discrete sets the system in the selftest mode in which it outputs synthetic generated system data via its interfaces (refer to section 1, paragraph 5). The input Selftest Data Enable discrete has a GND/Open (SGS) logic. A GND signal on the Selftest Data Enable discrete enables the selftest mode.

DG/MAG Mode Select

The DG/MAG Mode select discrete is a 28 VDC/Open (SAV) input that controls the system to operate either in MAG mode or in DG mode.

The logic of the input is configurable by the DG Mode Logic Select discrete (refer to section 1, paragraph 4.2.1.2).

Slew Left/Right

The system has one slew left discrete and one slew right discrete. Both slew discretes are 28 VDC/Open signals.

A 28 VDC signal on the slew left or slew right discrete enables the slew function to slew the platform heading to the left (CCW) or to the right (CW) respectively as defined in section 2, paragraph 5.4.2.4.

On GND / In Air

The On Ground / In Air discrete is a GND/Open signal that indicates whether the aircraft is on ground or in air. The logic of the input is configurable by the Ground/Air Logic Select discrete (refer to section 1, paragraph 4.2.1.2).

DADS Select

This input is used as control discrete to select the active DADS input with the logic defined in the following table.

Program Pin	Function			
	Automatic	DADS No. 1	DADS No. 2	No DADS/BASIC
DADS select No.1	open	open	GND	GND
DADS select No.2	open	GND	open	GND

Table 1-26 DADS Input Select

The DADS select function is only applicable for systems without synchro interface module (LCR-100 P/N 145130-1xxx, -3000 and -6xxx). Otherwise these pins are used as Yaw Rate Scale Factor Select discretes (refer to section 1, paragraph 4.2.1.2).

Attitude Mode Select

Only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000)

The Attitude Mode discrete is a GND/Open signal.

The logic of the Attitude Mode Select Discrete is defined in the following table:

Attitude Mode Select Discrete	141530-1xxx; -2xxx and -3000 except -1002 and -1005	145130-1002 and -1005
Open	Inactive	Attitude mode selected
GND	Attitude mode selected	Inactive

Table 1-27 Attitude Mode Select

Description of Attitude Mode: refer to section 2, paragraph 5.4.3.2.

Gyrocompass Mode Select

Only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000)

The Gyrocompass Mode discrete is a GND/Open signal.
A GND signal on the Gyrocompass Mode discrete sets the system in the Gyrocompass Mode. Description of Gyrocompassing: refer to section 2, paragraph 5.3.5.1.

Stored Heading Alignment

Only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000)

The Stored Heading Alignment discrete is a GND/Open signal.

A GND signal on the Stored Heading Alignment discrete sets the system in the Stored Heading Alignment Mode. Description of Stored Heading Alignment: refer to section 2, paragraph 5.3.5.2.

Synchro True/Mag Heading Select

Only applicable to AHRS systems with P/N 145130-2xxx.

The Synchro True/Mag Heading Select discrete selects whether there is true heading or Magnetic heading output on the synchro heading channels 1 and 2.

The Synchro True/Mag Heading Select discrete is a GND/Open signal.

If a GND signal applies on the Synchro True/Mag Heading Select discrete, the system outputs true heading on the heading synchro channels 1 and 2.

MSU Calibration

The MSU Calibration Mode discrete is a 28 VDC/Open signal.

A 28 VDC signal on the MSU Calibration Mode discrete sets the system to the MSU Calibration Mode. Description of MSU Calibration Mode: refer to section 2, paragraph 5.5.

Maintenance Test Mode

The discrete will only be checked and accepted at power on and if the aircraft is determined to be on ground.

The input is referenced to AHRU internal ground.

A jumper between a ground contact on J6 (e.g. Pin 17) and the test mode discrete input sets the system into the maintenance test mode. Description of Maintenance Test Mode: refer to section 2, paragraph 5.8.

Fan Test Enable

A jumper between the power supply pins J2-04/05 enables the fan current monitoring on the PSM.

Normal Acceleration Test Enable

Only applicable for systems with installed synchro interface module (LCR-100 P/N 145130-2xxx and -7xxx)

The system provides a Normal Acceleration Test Enable (NATE) discrete input.

-15 VDC ... -5 VDC	Test enabled
-2 VDC ... 0 VDC	Test disabled

The system accepts the reference for this input.

4.2.2 Discrete Output

The system provides the discrete outputs defined in the following table.

Discrete Output	Logic		Connector/Pin
Aux Power Annunciation	Open Signal Ground Signal	= primary power available = no primary power available	J1-07
System Warn	A-B open; B-C closed A-B closed B-C open	 = System warn / alignment = System valid	J4-21 (A) J4-42 (B) J4-15 (C)
Yaw Rate Warn (1)	Contact closed Contact open	= Yaw Rate valid = Yaw Rate Warn	J4-41 (A) J4-61 (B)
Basic Mode Annunciator (2)	Contact closed Contact open	= Basic Mode = Normal Mode	J4-41 (A) J4-61 (B)
Auto Pilot HDG Interlock	Contact closed Contact open	= Heading valid = Heading invalid	J4-19 (A) J4-40 (B)
ATT Mode Annunciator (3)	Contact closed Contact open	= Attitude Mode = Navigation Mode	J4-62 (A) J4-20 (B)
DG Mode Annunciator (4)	Contact closed Contact open	= Directional Gyro Mode = Slaved Heading Mode	J4-62 (A) J4-20 (B)
Attitude Warn (1)	Contact closed Contact open	= Attitude valid = Attitude invalid	J3-03 (A) J3-18 (B)
Heading Warn 1 (1)	Contact closed Contact open	= Heading valid = Heading invalid	J3-32 (A) J3-17 (B)
Heading Warn 2 (1)	Contact closed Contact open	= Heading valid = Heading invalid	J3-16 (A) J3-01 (B)
Turn Rate Warn (1)	Contact closed Contact open	= Turn Rate valid = Turn Rate invalid	J3-02 (A) J3-31 (B)

Table 1-28 Discrete Output

1) Only applicable for systems with installed synchro interface module (LCR-100 P/N 145130-2xxx and -7xxx)
2) Only applicable for systems without synchro interface module (LCR-100 P/N 145130-1xxx, -3000 and -6xxx)
3) Not applicable for LCR-100 with P/N 145130-6002, -6200, -7001, -7011, -7100 and -7110
4) Only applicable for LCR-100 with P/N 145130-6002, -6200, -7001, -7011, -7100 and -7110

The outputs are built as relay contacts, which can switch resistive loads with currents up to 110 mA.

AUX Power Annunciation

The AUX power indication output (J1, Pin 07) indicates whether primary power is available at the system with the logic defined in Table 1-28.

System Warn

The system warn output indicates the status of the alignment and the health state of the system during operation with the logic defined in Table 1-28.

NOTE

The system warn discrete is to be used in conjunction with MASTER CAUTION display systems - but not for primary flight displays and flight control systems!

Yaw Rate Warn

Only applicable for systems with installed synchro interface module (LCR-100 P/N 145130-2xxx and -7xxx)

The rates warn output indicates whether the BIT detects any failure that could affect the output of the yaw rate with the logic defined in Table 1-28.

Basic Mode Annunciator

Only applicable for systems without synchro interface module (LCR-100 P/N 145130-1xxx, -3000 and -6xxx)

The Basic Mode Annunciator output indicates when the system operates in basic attitude mode with the logic defined in Table 1-28.

Auto Pilot Heading Interlock

The Auto Pilot Heading Interlock contact is open when the heading is invalid.

The Auto Pilot Heading Interlock contact is opened for 2 seconds when the heading output is altered more than 1 degree at transition from DG Mode to MAG Mode or by selecting the slew left or slew right function during MAG mode.

In DG mode the Auto Pilot Heading Interlock contact is opened for at least 2 seconds when the slew left or slew right function is selected or a heading set command is received.

The Auto Pilot Heading Interlock contact is opened when the system operates in MSU calibration mode.

ATT Mode Annunciator

Not applicable for LCR-100 with P/N 145130-6002, -6200, -7001, -7011, -7100 and -7110

The ATT Mode Annunciator output indicates when the system operates in attitude mode with the logic defined in Table 1-28.

DG Mode Annunciator

Only applicable for LCR-100 with P/N 145130-6002, -6200, -7001, -7011, -7100 and -7110

The DG Mode Annunciator output indicates when the system operates in directional gyro mode with the logic defined in Table 1-28.

Synchro Interface Module Discrete Output (Attitude, Heading and Turn Rate warn)

The validity determination of the discretes located on the Synchro Interface Module defined in Table 1-28 includes the wrap around test of the corresponding synchro interface output.

Example

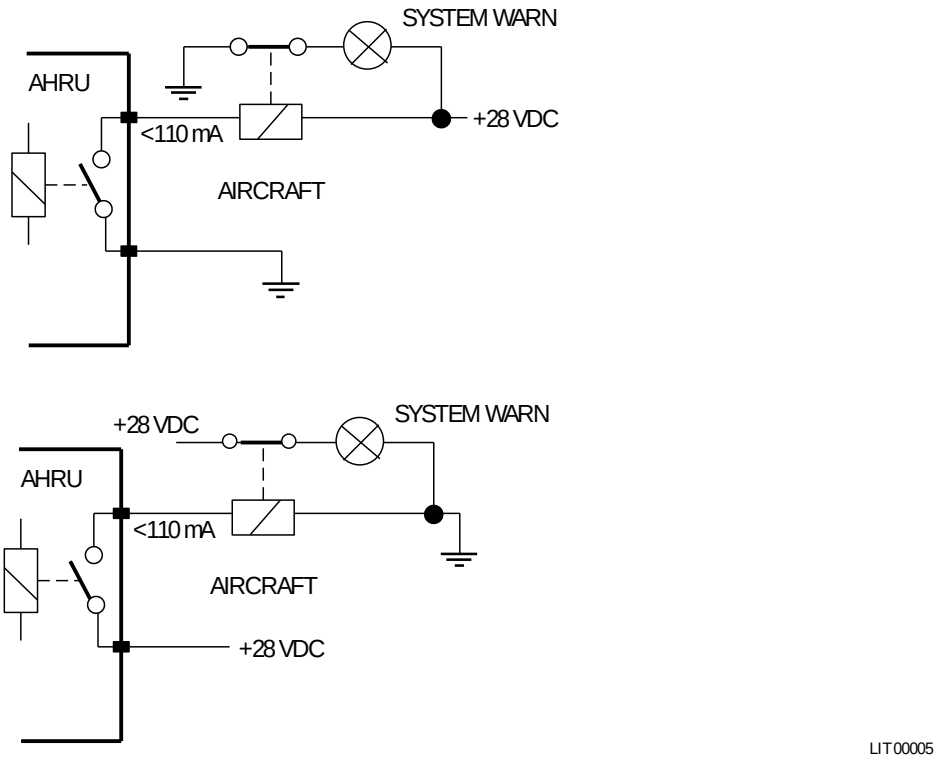


Figure 1-5 Examples of a typical Wiring of a Discrete Output, e.g. System Warn

4.3 Digital Interfaces

4.3.1 Digital Input

4.3.1.1 ARINC 429 Input

The system provides the input defined in the following table according to ARINC 429 specifications ARINC 429-P1-17, ARINC 429-P2-16, ARINC 429-P3-18.

ARINC 429 Input Data Bus No.	Speed	Data Source
1, 2	High/Low	DADS
3, 4	High/Low	GNSS
5, 6	High/Low	CDU/FMS

Table 1-29 ARINC 429 Inputs

If not stated otherwise for particular Labels, the system evaluates the Sign Status Matrix (SSM) of the received ARINC Labels as defined in the following table.

	Bit 31	Bit 30	Designation
BNR	0	0	Failure Warning
	0	1	No computed data
	1	0	Functional Test
	1	1	Normal Operation
BCD	0	0	Normal Operation (positive)
	0	1	No computed data
	1	0	Functional Test
	1	1	Normal Operation (negative)
DIS	0	0	Normal Operation
	0	1	No computed data
	1	0	Functional Test
	1	1	Failure Warning

Table 1-30 SSM Designation for ARINC 429 Input Labels

Note: The setting of the SDI of the input Labels except for Label 043 and 275 is handled as don't care (applicable from MOD 20 upwards)

4.3.1.2 DADS Input

On the DADS input (Data Bus No. 1 and 2) the system accepts the following data from Digital Air Data Systems in accordance with ARINC 706-4.

Label (octal)	Parameter	Format	Min. Update Rate [Hz]	Signif. Bits	Max. Range	Approx. Resolution	Units	Pos. Sense
203	Pressure Altitude	BNR	8	17	131071	1.0	ft	up
210	True Airspeed	BNR	8	15	2047.93	0.0625	kts	forward
215 (1)	Impact Pressure	BNR	8	14	511.97	0.03125	mb	always positive
350	Maintenance Discrete Word 1	DIS	1	N/A	N/A	N/A	N/A	N/A

Table 1-31 Digital Air Data Input

1) Only applicable for LCR-100 P/N 145130-6001

The system provides the capability to process data of one or two Digital Air Data Systems (DADS). The system automatically selects the link speed of the DADS ARINC 429 inputs.

The input channel selection is controlled by the DADS select discretes (refer to section 1, paragraph 4.2.1.3). For variants without the DADS Select discretes the automatic selection is active all the time.

If automatic selection is active the DADS input 1 channel is the preferred input. In the automatic selection mode the DADS input 2 is only used during times, when input 1 is invalid.

The processing of Label 350 on the DADS input is activated by a programming constant in the IDM. If this function is activated, bit 11 and 12 of Label 350 are interpreted as defined in the following table.

Bit No.	Function	Bit Status	
		1	0
1-8	Label		
9-10	SDI Field		
11	TAS	Invalid	Valid
12	Altitude	Invalid	Valid
13-29	don't care		
30-31	SSM		
32	Odd Parity		

Table 1-32 DADS Status Input Label 350

NOTE

The following statement including Table 1-33 is only applicable for the LCR-100-Systems with P/N 145130-1002 and -1005

On DADS input 1 the system accepts the GNSS defined in the following GNSS input table additionally to the DADS data.

Label	Parameter	Format	Units	pos. Sense	Range	sign. Bits	Resolution	Update Rate [Hz]
101	HDOP	BNR	N/A	(1)	1024	15	0.031	1
110	GNSS Latitude	BNR	degree	N	± 180	20	0.000172	1
111	GNSS Longitude	BNR	degree	E	± 180	20	0.000172	1
120	GNSS Latitude Fine	BNR	degree	(2)	0.000172	11	8.38E-8	1
121	GNSS Longitude Fine	BNR	degree	(2)	0.000172	11	8.38E-8	1
166	N/S Velocity	BNR	knots	N	± 4096	15	0.125	1
174	E/W Velocity	BNR	knots	E	± 4096	15	0.125	1
247	Horizontal FOM	BNR	nm	(1)	16	18	6.1E-5	1
273 (3)	GNSS Sensor Status	DIS	N/A	N/A	N/A	N/A	N/A	1

Table 1-33 GNSS Data Input for LCR-100-System with P/N 145130-1002 and -1005.

1) Always positive.

2) Fine data words contain truncated portion of the original data word.

3) Label 130 and 273 according ARINC 743A-4 (refer to Table 1-35 and Table 1-37 in section 1, paragraph 4.3.1.3.)

4.3.1.3 GNSS Input

NOTE

This paragraph is only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000), except for P/N 145130-1002 and -1005!

On the GNSS input (Data Bus No. 3 and 4) the system accepts data from Global Navigation Satellite Systems (e.g. GPS) in accordance with ARINC 743A. - **Note:** for GNSS input data according to ARINC 743 refer to Table 1-34.
The system provides the capability to process GNSS data from either GNSS input channel 1 or GNSS input channel 2. The GNSS input channel 1 is the preferred input. The GNSS input channel 2 is only used, when GNSS input channel 1 is invalid.

The system accepts the GNSS data as defined in the following table.

Label	Parameter	Format	Units	Pos. Sense	Range	Sign. Bits	Resolution	Update Rate [Hz]
076	GNSS Altitude (MSL)	BNR	feet	Up	± 131072	20	0.125	1
101	HDOP	BNR	N/A	(1)	1024	15	0.031	1
102	VDOP	BNR	N/A	(1)	1024	15	0.031	1
110	GNSS Latitude	BNR	degree	N	± 180	20	0.000172	1
111	GNSS Longitude	BNR	degree	E	± 180	20	0.000172	1
120	GNSS Latitude Fine	BNR	degree	(2)	0.000172	11	8.38E-8	1
121	GNSS Longitude Fine	BNR	degree	(2)	0.000172	11	8.38E-8	1
130	Horiz. Integrity Limit	BNR	nm	(1)	16	refer to notes (3) and (4)		1
133	Vert. Integrity Limit (4)	BNR	feet	(1)	32768	17	0.25	1
136	Vertical FOM	BNR	feet	(1)	32768	18	0.125	1
140	UTC Fine	BNR	s	(2)	1.0	20	0.9536743 µs	1
150	UTC	BNR	hr:min:s	(1)	23:59:59	17	1.0 s	1
165	Vertical Velocity	BNR	ft/min	Up	± 32768	15	1.0	1
166	N/S Velocity	BNR	knots	N	± 4096	15	0.125	1
174	E/W Velocity	BNR	knots	E	± 4096	15	0.125	1
247	Horizontal FOM	BNR	nm	(1)	16	18	6.1E-5	1
260	Date	BCD	d:m:y	(1)	N/A	6	1 Day	1
273	GNSS Sensor Status refer to notes (3), (5) and (6)	DIS	N/A	N/A	N/A	N/A	N/A	1

Table 1-34 GNSS Data Input

1) Always positive
2) Fine data words contain truncated portion of the original data word
3) Label 130 and 273 according ARINC 743A-4 (refer to Table 1-35, Table 1-37 and Table 1-38)
4) Label 133 not required for LCR-100 with P/N 145130-1003
5) Labels 130 and 273 according to ARINC 743 (only for LCR-100 with P/N 145130-1003) (refer to Table 1-36, Table 1-40, Table 1-41 and Table 1-42.)
6) For P/N 145130-3000 only: Label 273 according to ARINC 743B as defined in Table 1-39 is also accepted

Label 130 (applicable for all LCR-100 except of P/N 145130-1003)

Bit No.	Function	Description
1-8	Label	
9-10	SDI Field	
11	RAIM Detection Bit	0 = no failures 1 = not isolated satellite failure
12-28	Limit (in nm)	0-16 (LSB weight 1.22E-4)
29	Sign Bit	
30-31	SSM	
32	Odd Parity	

Table 1-35 Label 130 on GNSS Data Input (all LCR-100 except 145130-1003)

Label 130 (only applicable for LCR-100 with P/N 145130-1003)

Bit No.	Function	Bit Status	
		1	0
1-8	Label		
9-10	SDI Field		
11-28	RAIM Detection Bit	0 - 16 (LSB = 6.10E-5)	
29	Sign Bit		
30-31	SSM		
32	Odd Parity		

Table 1-36 Label 130 on GNSS Data Input (only LCR-100 with P/N 145130-1003)

Label 273 (applicable for all LCR-100 except of P/N 145130-1003)

Bit No.	Function	Bit Status	
		1	0
1-8	Label		
9-10	SDI		
11	MSB of healthy Satellites visible	> 15	≤ 15
12	DADS Status	Not Present	Present
13	DADS Source	Secondary	Primary
14	IRS/FMS Status	Not Present	Present
15	IRS/FMS Source	Secondary	Primary
16-19	Number of Healthy Satellites visible (LSB Bit 16)		
20-23	Number of Satellites Tracked (LSB Bit 20)		
24-28	GNSS Sensor Operational Mode	refer to Table 1-38 and Table 1-39	
29	MSB of Satellites tracked	> 15	≤ 15
30-31	SSM		
32	Parity (odd)		

Table 1-37 GNSS Sensor Status Word (Label 273) (all LCR-100 except 145130-1003)

Mode#	GNSS Sensor Operational Mode	Bit No.				
		28	27	26	25	24
1	Self Test Mode	0	0	0	0	0
2	Initialization Mode	0	0	1	0	0
3	Acquisition Mode	0	1	0	0	0
4	Navigation Mode	0	1	1	0	0
5	SBAS, NAV	0	1	1	0	1
6	GBAS, NAV	0	1	1	1	0
7	Alt/Clk Aiding	1	0	0	0	0
8	Reserved	1	0	1	0	0
9	Aided	1	1	0	0	0
10	Fault	1	1	1	1	1

Table 1-38 GNSS Sensor Operational Mode (from Table 1-37)

Mode#	GNSS Sensor Operational Mode	Bit No.				
		28	27	26	25	24
1	Self Test Mode	0	0	0	0	0
2	Initialization Mode	0	0	1	0	0
3	Acquisition Mode	0	1	0	0	0
4	Navigation Mode	0	1	1	0	0
5	SBAS, NAV	0	1	1	0	1
6	GBAS, NAV	0	1	1	1	0
7	Approach	0	1	1	1	1
8	Alt/Clk Aiding	1	0	0	0	0
9	Reserved	1	0	1	0	0
10	Aided	1	1	0	0	0
11	Fault	1	1	1	1	1

Table 1-39 GNSS Sensor Operational Mode (from Table 1-37) for P/N 145130-3000 only

Label 273 (only applicable for LCR-100 with P/N 145130-1003)

Bit No.	Function	Bit Status	
		1	0
1-8	Label		
9-10	SDI		
11	Control data Input from	Channel 2	Channel 1
12-15	N/A		
16	Fail Control Data Input No. 1	Fail	Normal
17	Fail Control Data Input No. 2	Fail	Normal
18	Fail input differential correction	Fail	Normal
19	Test	On	Off
20-23	Number of healthy Satellites visible (0..15)		
24-25	GNSS Sensor Type	refer to Table 1-41	
26-28	GNSS Sensor Operational Mode	refer to Table 1-42	
29	MSB of healthy Satellites visible (16)		
30-31	SSM		
32	Parity (odd)		

Table 1-40 GNSS Sensor Status Word (Label 273) (only LCR-100 P/N 145130-1003)

Bit No.		Sensor Type
25	24	
0	0	GPS
1	0	GLONASS
1	1	GPS/GLONASS
0	1	N/A

Table 1-41 GNSS Sensor Type (from Table 1-40)

Bit No.			Operational Mode
28	27	26	
0	0	0	N/A
0	0	1	N/A
0	1	0	Startup
0	1	1	Autonomous
1	0	0	N/A
1	0	1	
1	1	0	N/A
1	1	1	N/A

Table 1-42 GNSS Sensor Operational Mode (from Table 1-40)

4.3.1.4 Input from CDU/FMS

On the CDU/FMS input (Data Bus No. 5 and 6) the system accepts the ARINC 429 Labels as defined in the following table.

Label	Parameter	Format	Units	Range	Resolution	Update Rate [Hz]	Digits	Pos Sense
041 (3)	Set Latitude	BCD	deg	90S - 90N	0.1 arcmin	2	6	N/A
042 (3)	Set Longitude	BCD	deg	180E - 180W	0.1 arcmin	2	6	N/A
043 (1)(3)(4)	Set Mag Heading	BCD	deg	0 - 359	0.1 deg	2	4	N/A
260	Date	BCD	d:m:y	N/A	1 Day	1	6	N/A
275 (1)	Command Discrete	DIS	N/A	N/A	N/A	2	N/A	N/A
310 (2)	Set Latitude	BNR	deg	±180	0.000172	1	20	N/A
311 (2)	Set Longitude	BNR	deg	±180	0.000172	1	20	N/A

Table 1-43 ARINC 429 Inputs from CDU/FMS

1) For LCR-100 Systems with P/N 145130-1000, -2xxx and -3000 and beginning from MOD 20 on: SDI recognition. The system accepts Label 043 and 275 only if the SDI setting of the Label matches with the SDI setting of the LCR-100 AHRU.
2) Only for LCR-100 Systems with P/N 145130-1000, -2xxx and -3000
3) Labels 041, 042 and 043 are only accepted as valid, if they are received two times within 3 seconds with identical content
4) During index error compensation the range for Label 043 is ± 5 deg

The priority of the position input is as follows:

- Priority 1 (highest): FMS position Labels 041/042
- Priority 2: FMS position Labels 310/311(only for LCR-100 Systems with P/N 145130-1000, -2xxx and -3000)
- Priority 3: GNSS position Labels 110/111 (GNSS input channels)

If a position on a higher priority Label has been detected all lower priority Labels will be overwritten.

The command discrete Label 275 is interpreted as defined in the following table.

Bit No.	Function	Bit Status	
		1	0
1-8	Label		
9-10	SDI Field	refer to Table 1-18 and Table 1-47	
11	ARINC Selftest command input (1)	Enabled	Disabled
12	ARINC DG/MAG Mode command input (1)	Enabled	Disabled
13	Not used		
14	ARINC DADS select command input (1)	Enabled	Disabled
15	ARINC Attitude mode command input (1) (2)	Enabled	Disabled
16	ARINC Gyrocompass Command input (1) (2)	Enabled	Disabled
17	ARINC Stored HDG Align Command input (1) (2)	Enabled	Disabled
18	Selftest Data Enable	Selftest	Normal
19	DG/MAG Mode Select	Mag Mode	DG Mode
20	Not used		
21	Not used		
22	DADS Select 2	refer to Table 1-45	
23	DADS Select 1	refer to Table 1-45	
24	Attitude Mode Select (2) (4)	Selected	Inactive
25	Gyrocompass Mode Select (2) (5)	Selected	Inactive
26	Stored Heading Alignment (2)	Enabled	Disabled
27	Hybrid GNSS augmentation (2)	Disabled	Enabled
28	Re-Initialization of Hybrid Kalman-Filter (6)	Selected	Inactive
29	Parity (3)		
30-31	SSM		
32	Odd Parity		

Table 1-44 Command Discrete (Label 275)

1) This bit enables or disables the acceptance of the corresponding command Bit in the command discrete word. If the ARINC command is active the discrete command will be ignored.
2) Only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000)
3) The parity of bit 11 to bit 29 has to be set to odd by the parity bit.
4) Trigger command: The Mode will be continued independent of the state of the command.
5) Trigger command: The Mode will be started and continued independent of the state of the command. If the command is still set at the end of the gyrocompassing alignment the system remains in the gyrocompassing mode. As long as the Attitude Mode Select command is set the Gyrocompass Mode Select command is disabled.
6) Only for P/N 145130-3000: Reaction on rising edge only

Bit No.		DADS Input
22	23	
0	0	Automatic
0	1	DADS No. 1
1	0	DADS No. 2
1	1	No DADS

Table 1-45 ARINC 429 DADS Select Command

The status of the last valid command input Label 275 is latched. The latched status of the input Label 275 is output on the ARINC output busses.

4.3.1.5 Time Mark

This paragraph is only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000)

Without Time Mark signal GNSS data will not be used.

The system provides two Time Mark inputs (A and B) in accordance with ARINC 743 (electrically like RS 422).

Time Mark A is available on J4 and J6 as defined in Table 1-87 and Table 1-89. Both Time Mark A inputs must not be used in one installation. The Time Mark A input is allocated to the GNSS input channel 1 and GNSS data received on DADS input channel 1.

The Time Mark B input is allocated to the GNSS input channel 2.

The system expects that the data allocated to a Time Mark are completely available on the input before the next Time Mark pulse is received.

4.3.2 Digital Output

4.3.2.1 ARINC 429 Output

The system provides 6 high speed ARINC 429 outputs according to ARINC specifications ARINC 429-P1-17, ARINC 429-P2-16, ARINC 429-P3-18. Each output is buffered separately. The ARINC word parity bit is always rendered odd.

If not stated otherwise for particular Labels, the system sets the Sign Status Matrix (SSM) of the transmitted ARINC Labels as defined in the following table.

	Bit 31	Bit 30	Designation
BNR	0	0	Failure Warning
	0	1	No computed data
	1	0	Functional Test
	1	1	Normal Operation
BCD	0	0	Normal Operation (positive)
	0	1	No computed data
	1	0	Functional Test
	1	1	Normal Operation (negative)
DIS	0	0	Normal Operation
	0	1	No computed data
	1	0	Functional Test
	1	1	Failure Warning

Table 1-46 SSM Designation for ARINC 429 Output Labels

The SDI bit setting is defined by the SDI input discretes (refer to chapter 4.2.1.2 and Table 1-47).

System	Bit 10	Bit 9
n/a	0	0
No. 1	0	1
No. 2	1	0
No. 3	1	1

Table 1-47 SDI Bit Setting

4.3.2.1.1 AHRS Data

The system provides the following AHRS data according to ARINC 705-5. For notes ( ) of the following table refer to section 1, paragraph 4.3.2.1.4.

Label	Parameter	For-mat	Max. Signal Band-width [Hz]	Max. Delay [ms] (20)	Update Rate [Hz]	Signif. Bits	Max. Range	Approx. Resolu-tion	Selftest Value	Units	Positive Sense
040 (16)	Body Yaw / Turn Rate	BNR	8/1.1 (4)	30	100/50 (18)	18	± 128	0.00048	+ 10°/s	deg/s	Nose right
046 (19)	Software Version	BCD	N/A	N/A	2	N/A	N/A	N/A	Version #	N/A	N/A
151	System Discrete Word 4	DIS			2						
152	System Discrete Word 5	DIS			2						
155	Configuration Discrete Word 1	DIS			2	N/A	N/A	N/A	N/A	N/A	N/A
156	Configuration Discrete Word 2	DIS			2	N/A	N/A	N/A	N/A	N/A	N/A
215 (14,16)	Impact Pressure	BNR			10	14	512	.03125	N/A	mb	Always Positive
270	System Discrete Word 1	DIS			2/10 (18)	N/A	N/A	N/A	(*)	N/A	N/A
271	System Discrete Word 2	DIS			2/10 (18)	N/A	N/A	N/A	N/A	N/A	N/A
272	System Discrete Word 3	DIS			2	N/A	N/A	N/A	N/A	N/A	N/A
275	Command Discrete	DIS			2	N/A	N/A	N/A	N/A	N/A	N/A
300 (1)	Magnetic Sensor Input	BNR			20	18	± 180	0.00068	N/A	deg	CW from North
301 (6,8,9)	Body Normal Accel.	BNR	8 (4)	40/22 (22)	100/50 (17)	18	± 8	0.00003	+ 0.1 g	g	Up
302	System Time	BNR			2	19	524287	1.0	N/A	s	
303	Input Discrete Word 1	DIS			2	N/A	N/A	N/A	N/A	N/A	N/A
304	Input Discrete Word 2	DIS			2/10 (18)	N/A	N/A	N/A	N/A	N/A	N/A
305	Alignment Countdown	BNR			2	18	4096	0.015	N/A	s	
306 (1)	MSU Fieldstrength	BNR			20	18	131072	0.5	N/A	nT	
314 (15,24)	True Heading	BNR		110	20	18	± 180	0.00068	+ 10°	deg	CW from North
320	Mag Heading	BNR		110	50/25 (17)	18	± 180	0.00068	+ 15°	deg	CW from North
324	Pitch Angle	BNR		20	100/50 (17)	18	± 180	0.00068	+ 5°	deg	Nose Up
325	Roll Angle	BNR		20	100/50 (17)	18	± 180	0.00068	+ 45°	deg	Right Wing Down
326 (2)	Body Pitch Rate	BNR	8 (4)	45/22 (22)	100/50 (17)	18	± 128	0.00048	+ 10°/s	deg/s	Nose up

Label	Parameter	For-mat	Max. Signal Band-width [Hz]	Max. Delay [ms] (20)	Update Rate [Hz]	Signif. Bits	Max. Range	Approx. Resolu-tion	Selftest Value	Units	Positive Sense
327 (2)	Body Roll Rate	BNR	8 (4)	45/22 (22)	100/50 (17)	18	± 128	0.00048	+ 10°/s	deg/s	Right Wing Down
330 (2,5,27)	Body Yaw / Turn Rate	BNR	8/1.1 (4)	45/22 (22)	100/50 (17)	18	± 128	0.00048	+ 10°/s	deg/s	Nose Right
331 (3,9,21)	Body Long. Accel.	BNR	8/3 (4,29)	45/22 (22)	100 /50 (17)	18	± 4	0.000015	+ 0.02 g	g	Forward
332 (3,9,21)	Body Lat. Accel.	BNR	8/3 (4,29)	45/22 (22)	100/50 (17)	18	± 4	0.000015	+ 0.1 g	g	Right
333 (3,6,9, 21)	Body Normal Accel.	BNR	8/3 (4,29)	45/22 (22)	100/50 (17)	18	± 4	0.000015	+ 0.1 g	g	Up
334 (1)	Magnetic Sensor Input	BNR			20	18	± 180	0.00068	+ 22.5°	deg	CW from North
336 (2)	Pitch Att. Rate	BNR	8 (4)	45	50	18	± 128	0.00048	+ 10°/s	deg/s	Nose Up
337 (2)	Roll Att. Rate	BNR	8 (4)	45	50	18	± 128	0.00048	+ 10°/s	deg/s	Right Wing Down
340 (2,5,27)	Turn / Body Yaw Rate	BNR	8 / 1.1 (4)	45/22 (22)	100 / 50 (17)	18	± 128	0.00048	+ 10°/s	deg/s	Nose Right
350	Maintenance Discrete Word 1	DIS			2/10 (18)	N/A	N/A	N/A	N/A	N/A	N/A
351	Maintenance Discrete Word 2	DIS			2/10 (18)	N/A	N/A	N/A	N/A	N/A	N/A
352	Maintenance Discrete Word 3	DIS			2/10 (18)	N/A	N/A	N/A	N/A	N/A	N/A
353	Maintenance Discrete Word 4	DIS			2/10 (18)	N/A	N/A	N/A	N/A	N/A	N/A
354 (1)	MSU Cal. Error	BNR			10	18	± 1.8	6.9E-6	N/A	deg	
356	System Input Status Word	DIS			2	N/A	N/A	N/A	N/A	N/A	N/A
361 (9)	Inertial Altitude	BNR		65	25	18	±131072	0.5	10,000 ft	feet	Up
364 (3, 7,9,21)	Vertical Accel.	BNR	8/3 (4,29)	60	50	18	± 4	0.000015	+ 0.1 g	g	Up
365 (9)	Inert. Vert. Speed	BNR	8 (30)	30	25/50 (23)	18	± 32768	0.125	- 600 ft/min	ft/min	Up
375 (9,21)	Along Hdg. Accel.	BNR	8/3 (4,29)	40	50	18	± 4	0.000015	+ 0.02 g	g	Forward
376 (9,21)	Cross Hdg. Accel.	BNR	8/3 (4,29)	40	50	18	± 4	0.000015	+ 0.02 g	g	Right
377	Equipment Identification	BCD	N/A	N/A	2	N/A	N/A	N/A	N/A	N/A	N/A

Table 1-48 ARINC 429 AHRS Data Output

Note: (*) N/A except for

bit 13: selftest value: Basic Mode

bit 16: selftest value of Autopilot Heading Interlock discrete

4.3.2.1.2 IRS Data

NOTE

The IRS data output is only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000), except P/N 145130-1001, -1002 and -1005.

The system provides the IRS data defined in the following table. For notes ( ) of the following table refer to section 1, paragraph 4.3.2.1.4.

Label	Parameter	Format	Max. Signal Bandwidth [Hz]	Max. Delay [ms] (20)	Update Rate [Hz]	Signif. Bits	Max. Range	Resolution	Selftest Value	Units	Positive Sense
147	Magnetic Variation	BNR			5	18	± 180	0.00068	+ 10	deg	CW from North
310	Present Pos Lat	BNR	2	160	5	20	± 180	0.000172	N22.50°	deg	North from zero
311	Present Pos Long	BNR	2	160	5	20	± 180	0.000172	E22.50°	deg	East from Zero
312	Ground Speed	BNR	2	110	10	18	± 4096	0.015	200 kts	knots	Always Positive
313 (11)	Track Angle True	BNR	2	110	20	18	± 180	0.00068	0.0°	deg	CW from North
315	Wind Speed	BNR	0.125	110	10	18	256	0.00097	100 kts	knots	Always Positive
316 (10)	Wind Direction True	BNR	0.125	110	10	18	± 180	0.00068	30°	deg	CW from North
317 (11)	Track Angle Mag	BNR	2	110	20	18	± 180	0.00068	5°	deg	CW from North
321 (11)	Drift Angle	BNR	2	110	20	18	± 180	0.00068	- 10°	deg	Right
322 (12)	Flight Path Angle	BNR	2	110	20	18	± 180	0.00068	- 5°	deg	Up
323 (3,12)	Flight Path Accel	BNR	8 (4)	60	50	18	± 4	0.000015	0.02 g	g	Forward
335 (11)	Track Angle Rate	BNR	4 (4)	40	50	18	± 32	0.00012	4°/s	deg/s	CW
360 (12,28)	Potential Vert Spd.	BNR	8	65	50	18	± 32768	0.125	- 600 ft/min	ft/min	Up
362 (11)	Along Tk horiz. Accel	BNR	8	60	50	18	± 4	0.000015	0.02 g	g	Forward
363 (11)	Cross Tk horiz. Accel	BNR	8	60	50	18	± 4	0.000015	0.02 g	g	Right
366	N-S Velocity True	BNR	2	110	10	18	± 4096	0.015	+ 200 kts	knots	North
367	E-W Velocity True	BNR	2	110	10	18	± 4096	0.015	+ 200 kts	knots	East
372 (10)	Wind Direction Magnetic	BNR	0.125	110	10	18	± 180	0.00068	+ 30°	deg	CW from North
373	N-S Vel. Mag	BNR	2	110	10	18	± 4096	0.015	+ 200 kts	knots	North
374	E-W Vel. Mag	BNR	2	110	10	18	± 4096	0.015	+ 200 kts	knots	East

Table 1-49 ARINC 429 IRS Data Output

4.3.2.1.3 Hybrid Data

NOTE

The hybrid data output is only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000) except P/N 145130-1001, -1002 and -1005 (hybrid data for LCR-100 P/N 145130-1002 and -1005: refer to Table 1-51).

The system provides the hybrid data defined in the following table. For notes ( ) of the following table refer to section 1, paragraph 4.3.2.1.4.

Label	Parameter	Format	Max. Signal Bandwidth [Hz]	Max. Delay [ms]	Update Rate [Hz]	Signif. Bits	Max. Range	Resolution	Selftest Value	Units	Positive Sense
55 (26)	Hybrid Mag Heading	BNR		110	50	18	± 180	0.00068	+ 15°	deg	CW from North
104	Hybrid Wind Speed	BNR	--	110	10	18	256	0.00097	100 kts	knots	Always Positive
105 (10)	Hybrid Wind Direction True	BNR	--	110	10	18	± 180	0.00068	30°	deg	CW from North
106 (10)	Hybrid Wind Direction Mag.	BNR	--	110	10	18	± 180	0.00068	+ 30°	deg	CW from North
132	Hybrid True Heading	BNR	2	110	50	18	± 180	0.00068	+ 10°	deg	CW from North
134 (12, 21)	Hybrid Potential Vert. Spd.	BNR	8	65	50	18	± 32768	0.125	- 600 ft/min	ft/min	Up
135	Hybrid Vertical FOM	BNR	N/A	110	2	18	32768	0.125	N/A	ft	Always Positive
137 (11, 21)	Hybrid Track Angle True	BNR	2	110	50	18	± 180	0.00068	+ 5°	deg	CW from North
153 (11, 21)	Hybrid Track Angle Mag	BNR	2	110	20	18	± 180	0.00068	5°	deg	CW from North
154 (11, 21)	Hybrid Track Angle Rate	BNR	4 (4)	40	50	18	± 32	0.00012	4°/s	deg/s	CW
160 (11, 21)	Hybrid Drift Angle	BNR	2	110	20	18	± 180	0.00068	- 10°	deg	Right
175 (21)	Hybrid Ground Speed	BNR	2	110	20	18	± 4096	0.015	+ 200 kts	knots	Always Positive
254 (21)	Hybrid Latitude	BNR	2	160	10	20	± 180	0.000172	N 22.50	deg	North
255 (21)	Hybrid Longitude	BNR	2	160	10	20	± 180	0.000172	E 22.50	deg	East
256 (13, 21)	Hybrid Latitude Fine	BNR	2	160	10	18	0.000172	6.56E-10	0	deg	
257 (13, 21)	Hybrid Longitude Fine	BNR	2	160	10	18	0.000172	6.56E-10	0	deg	
261 (21)	Hybrid Altitude (MSL)	BNR	8	65	25	20	± 131,072	0.125	10,000 ft	ft	Up

Label	Parameter	For-mat	Max. Signal Band-width [Hz]	Max. Delay [ms]	Up-date Rate [Hz]	Signif. Bits	Max. Range	Resolu-tion	Selftest Value	Units	Positive Sense
262 (3, 12,21)	Hybrid Flight Path Accel	BNR	8 (4)	60	50	18	± 4	0.000015	0.02 g	g	Forward
263 (12, 21)	Hybrid Flight Path Angle	BNR	2	110	25	18	± 180	0.00068	- 5°	deg	Up
264 (25)	Hybrid Horizontal FOM	BNR	N/A	110	2	18	16	6.1E-5	N/A	nm	Always Positive
265 (26)	Hybrid Predicted Horizontal FOM	BNR	N/A	110	2	18	16	6.1E-5	N/A	nm	Always Positive
266 (21)	Hybrid N-S Velocity True	BNR	2	110	10/50 (23)	18	± 4096	0.015	+ 200 kts	knots	North
267 (21)	Hybrid E-W Velocity True	BNR	2	110	10/50 (23)	18	± 4096	0.015	+ 200 kts	knots	East
274	Hybrid Status Word	DIS	N/A	N/A	2	N/A	N/A	N/A	N/A	N/A	N/A
344	Hybrid Along HDG Velocity	BNR	N/A	110	25	18	± 4096	0.015	+ 40 kts	knots	Forward
345 (21)	Hybrid Vertical Velocity	BNR	8	65	25/50 (23)	18	± 32768	0.125	- 600 ft/min	ft/min	Up
346	Hybrid Across HDG Velocity	BNR	N/A	110	25	18	± 4096	0.015	+ 40 kts	knots	Right

Table 1-50 ARINC 429 Hybrid Data Output (24)

The LCR-100 systems with P/N 145130-1002 and -1005 provide the hybrid data defined in Table 1-51. For notes ( ) of the following table refer to section 1, paragraph 4.3.2.1.4.

Label	Parameter	For-mat	Max. Signal Band-width [Hz]	Max. Delay [ms]	Up-date Rate [Hz]	Signif. Bits	Max. Range	Resolu-tion	Selftest Value	Units	Positive Sense
132	Hybrid True Heading	BNR	2	110	50	18	± 180	0.00068	+ 10°	deg	CW from North
135	Hybrid Vertical FOM	BNR	N/A	110	2	18	32768	0.125	N/A	ft	Always Positive
137 (11, 21)	Hybrid Track Angle True	BNR	2	110	50	18	± 180	0.00068	+ 5°	deg	CW from North
147	Magnetic Variation	BNR			10	18	± 180	0.00068	+ 10	deg	CW from North
175 (21)	Hybrid Ground Speed	BNR	2	110	20	18	± 4096	0.015	+ 200 kts	knots	Always Positive
254 (21)	Hybrid Latitude	BNR	2	160	10	20	± 180	0.000172	N 22.50	deg	North
255 (21)	Hybrid Longitude	BNR	2	160	10	20	± 180	0.000172	E 22.50	deg	East
256 (13, 21)	Hybrid Latitude Fine	BNR	2	160	10	18	0.000172	6.56E-10	0	deg	
257 (13, 21)	Hybrid Longitude Fine	BNR	2	160	10	18	0.000172	6.56E-10	0	deg	

Label	Parameter	For-mat	Max. Signal Band-width [Hz]	Max. Delay [ms]	Up-date Rate [Hz]	Signif. Bits	Max. Range	Resolu-tion	Selftest Value	Units	Positive Sense
263 (12, 21)	Hybrid Flight Path Angle	BNR	2	110	25	18	± 180	0.00068	- 5°	deg	Up
264	Hybrid Horizontal FOM	BNR	N/A	110	2	18	16	6.1E-5	N/A	nm	Always Positive
266 (21)	Hybrid N-S Velocity True	BNR	2	110	25	18	± 4096	0.015	+ 200 kts	knots	North
267 (21)	Hybrid E-W Velocity True	BNR	2	110	25	18	± 4096	0.015	+ 200 kts	knots	East
274	Hybrid Status	DIS	N/A	N/A	10	N/A	N/A	N/A	N/A	N/A	N/A
312 (21)	Hybrid Ground Speed	BNR	2	110	20	18	± 4096	0.015	+ 200 kts	knots	Always Positive
315	Wind Speed	BNR		110	10	18	256	0.00097	100 kts	knots	Always Positive
316 (10)	Hybrid Wind Direction True	BNR		110	10	18	± 180	0.00068	30°	deg	CW from North
317 (11, 21)	Hybrid Track Angle Mag	BNR	2	110	20	18	± 180	0.00068	5°	deg	CW from North
321 (11, 21)	Hybrid Drift Angle	BNR	2	110	20	18	± 180	0.00068	- 10°	deg	Right
323 (3, 12, 21)	Hybrid Flight Path Accel	BNR	8 (4)	60	50	18	± 4	0.000015	0.02 g	g	Forward
335 (11, 21)	Hybrid Track Angle Rate	BNR	4 (4)	40	50	18	± 32	0.00012	4°/s	deg/s	CW
340	Hybrid Along HDG Velocity	BNR	8 (30)	110	25	18	± 4096	0.015	+ 40 kts	knots	Forward
341	Hybrid Across HDG Velocity	BNR	8 (30)	110	25	18	± 4096	0.015	+ 40 kts	knots	Right
366 (21)	Hybrid N-S Velocity Mag	BNR	2	110	20	18	± 4096	0.015	+ 200 kts	knots	North
367 (21)	Hybrid E-W Velocity Mag	BNR	2	110	20	18	± 4096	0.015	+ 200 kts	knots	East
372 (10)	Hybrid Wind Direction Mag	BNR	--	110	10	18	± 180	0.00068	+ 30°	deg	CW from North
373 (21)	Hybrid N-S Velocity Mag	BNR	2	110	10	18	± 4096	0.015	+ 200 kts	knots	North
374 (21)	Hybrid E-W Velocity Mag	BNR	2	110	10	18	± 4096	0.015	+ 200 kts	knots	East

Table 1-51 ARINC 429 Hybrid Data Output for LCR-100 P/N 145130-1002 and -1005

4.3.2.1.4 Notes to ARINC output tables:

These notes belong to the tables: Table 1-48; Table 1-49; Table 1-50 and Table 1-51.

All tolerances are ± 10 % unless otherwise noticed.

(1) Label 300 and 334 are the filtered and compensated magnetic sensor unit heading. For Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000) MSU related data is output only when a MSU is available.

(2) The system is capable of operating with angular rates of up to 600 deg/s. The output is limited to the maximum range.

(3) The system is capable of operating with an acceleration rate of up to 10 g. The output is limited to the maximum range.

(4) The Rates (except turn rate), Accelerations, Inertial Altitude and Inertial Vertical Speed outputs are filtered with a 2nd order low pass filter.
The turn rate is filtered by a 1st order low pass filter.

(5) Turn Rate is calculated from yaw rate and roll angle according to the following formula:
Turn rate = yaw rate / cos(roll angle)
For roll angles exceeding 60°, the roll angle is limited to 60°.

(6) Independent of the attitude of the system 1.0 g is subtracted from the measured acceleration. I.e. the leveled system outputs (1.0 – 1.0) g = 0.0 g, a 60° tilt results in (1.0 * cos60° - 1.0) g = (0.5 – 1.0) g = -0.5 g.

(7) When aircraft is resting on the ground, output is zero.

(8) The Normal Acceleration at Label 301 is identical to Label 333 except the output is limited to ± 8 g.

(9) After a Short Power Interrupt Label is NCD for 1.0 second when power returns.

(10) Set to zero for wind speed below 5 knots.

(11) The SSM of track angle is set to NCD for ground speed below 2 knots.

(12) The SSM is set to NCD for ground speed below 5 knots.

(13) The SSM of these Labels is set NCD, if Labels 120/121 are not available from GNSS receiver.

(14) Data is directly passed from DADS input to output without any alteration.

(15) Only applicable for Gyrocompass AHRS systems
(LCR-100 P/N 145130-1xxx, -2xxx and -3000)

(16) Only applicable for LCR-100 P/N 145130-6001

(17) Output rate depending on the setting of the program pin ARINC Update Rate Select (refer to section 1, paragraph 4.2.1.2).

(18) 10Hz update rate for LCR-100 System with P/N-145130-1002 and -1005 only.

(19) The last digit of the Software Version number show the actual MagVar Model (0: WMM 2005, 1: WMM 2010), e.g. 1500. Output with LCR-100 Systems P/N 145130-1xxx, -2xxx and -3000 only.

(20) Maximum delay is defined as the group delay including:
Delay of the FOG-IMU for providing data to the system +
Filter in System +
Computational delay +
Transmission delay

(21) These output values are transferred to the A/C Center of Gravity if the lever arms from the LCR-100 to the CoG are stored in the IDM. (applicable from MOD 20 upwards)

(22) 22 ms maximum delay (Only applicable to P/N 145130-1004)

(23) 50 Hz update rate (Only applicable to P/N 145130-1004)

(24) Not computed during Attitude mode and SSM set to NCD

(25) This value represents the 95% value of the hybrid navigation accuracy

(26) Output (Only applicable to P/N 145130-3000)

(27) Label 330 Body Yaw Rate, Label 340 Turn Rate (Only applicable to P/N 145130-3000 and 145130-1006 MOD-27)

(28) Not available for LCR-100 systems with P/N 145130-3000.

(29) 2nd order low pass filter with 3 Hz for PN -1005 only.

(30) 2nd order low pass filter with 8 Hz for PN -1005 only.

4.3.2.1.5 Discrete Words

Label 151

The system discrete word 4 in ARINC Label 151 has the following bit assignment:

Bit No.	Function	Bit No.	Function
1 - 8	Label	30 - 31	SSM
9 - 10	SDI	32	Parity (odd)
11 - 29	Configuration Word 4 (NG LITEF use only)		

Table 1-52 System Discrete Word 4 (Label 151)

Label 152

The system discrete word 5 in ARINC Label 152 has the following bit assignment:

Bit No.	Function	Bit No.	Function
1 - 8	Label	30 - 31	SSM
9 - 10	SDI	32	Parity (Odd)
11 - 29	Test and Maintenance (NG LITEF use only)		

Table 1-53 System Discrete Word 5 (Label 152)

Label 155

The configuration discrete word 1 in ARINC Label 155 has the following bit assignment:

Bit No.	Function		
1 - 8	Label	30 - 31	SSM
9 - 10	SDI	32	Parity (odd)
11 - 29	Configuration Word 1 (NG LITEF use only)		

Table 1-54 Configuration Discrete Word 1 (Label 155)

Label 156

The configuration discrete word 2 in ARINC Label 156 has the following bit assignment:

Bit No.	Function	Bit No.	Function
1 - 8	Label	22	Use Label 350 on DADS input channels
9 - 10	SDI	23 - 29	Not used (always 0)
11 - 13	Not used (always 0)	30 - 31	SSM
14 - 21	Installation Identifier (for GNSS Lever arm identification)	32	Parity (odd)

Table 1-55 Configuration Discrete Word 2 (Label 156)

Label 270

The system discrete word 1 in ARINC Label 270 has the following bit assignment. Table 1-56 is not applicable for LCR-100 P/N 145130-1001. For this special system refer to Table 1-58.

Bit No.	Function	Bit Status	
		1	0
1-8	Label		
9-10	SDI Field		
11	Align Mode / Ready	Aligning	Ready
12	Attitude / Navigation Mode (2)	Attitude	Navigation
13	Normal / Basic Mode (3) (4)	Normal	Basic
14	Slaved Mode / DG Mode (3) (4)	Slaved	DG
15	Attitude Invalid	Yes	No
16	Autopilot Heading Interlock	Invalid	Valid
17	Realignment Mode (1)	Yes	No
18	TAS fail	Yes	No
19	AHRU Fault	Yes	No
20	Synchro True/Mag HDG (1)	True	Mag
21	Align fail	Yes	No
22	No Position initialization (1)	Yes	No
23	Excessive Motion Error (1)	Yes	No
24	Stored Heading Alignment Enabled (1)	Yes	No
25	Extreme Latitude (1)	Yes	No
26-28	Align Status (1)	refer to Table 1-57	
29	Gyrocompass Plausibility Test (1)	Wait/Failed	Passed
30-31	SSM		
32	Odd Parity		

Table 1-56 System Discrete Word 1 (Label 270). N/A for LCR-100 P/N 145130-1001.

1) Only for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000). For Standard-AHRS systems (LCR-100 P/N 145130-6xxx and -7xxx) the Bit Status is always 0.

2) For Standard-AHRS systems (LCR-100 P/N 145130-6xxx and -7xxx) the Bit Status is always 1

3) For AHRS systems with P/N 145130-1xxx and -20X0: not Applicable in IRS operation (always 0)

4) For AHRS systems with P/N 145130-3000, -20X1 and -1006: If the unit is operating in navigation mode (IRS operation) bit 13 is set to 1, bit 14 is set according to DG mode command, if the unit is operating in attitude mode bits are set according to the definition in Table 1-56

Bit No.			Alignment Status
28	27	26	
1	1	1	time > 600 s
1	1	0	480 s < time ≤ 600 s
1	0	1	240 s < time ≤ 480 s
1	0	0	120 s < time ≤ 240 s
0	1	1	60 s < time ≤ 120 s
0	1	0	30 s < time ≤ 60 s
0	0	1	0 < time ≤ 30 s
0	0	0	Alignment finished / Ready to Nav

Table 1-57 Alignment Status Bit Assignment

Label 270

The system discrete word 1 in ARINC Label 270 has the following bit assignment. Table 1-58 is only applicable for LCR-100 P/N 145130-1001. For all other Systems refer to Table 1-56.

Bit No.	Function	Bit Status	
		1	0
1 - 8	Label		
9 - 10	SDI Field		
11	Align Mode/ Ready	Aligning	Ready
12	Slaved Mode / DG Mode	DG	Slaved
13	Normal / Basic Mode (1)	Normal	Basic
14	Attitude / Navigation Mode	Attitude	Navigation
15	Attitude Invalid	Yes	No
16	Autopilot Heading Interlock	Invalid	Valid
17	Realignment Mode	Yes	No
18	TAS fail	Yes	No
19	AHRU Fault	Yes	No
20	Synchro True/Mag HDG	True	Mag
21	Align fail	Yes	No
22	No Position initialization	Yes	No
23	Excessive Motion Error	Yes	No
24	Stored Heading Alignment Enabled	Yes	No
25	Extreme Latitude	Yes	No
26 - 28	Align Status	refer to Table 1-57	
29	Gyrocompass Plausibility Test	Wait/Failed	Passed
30 - 31	SSM		
32	Odd Parity		

Table 1-58 System Discrete Word 1 (Label 270).
Only applicable for LCR-100 P/N 145130-1001.

1) Not Applicable in IRS operation (always 0)

Label 271

The system discrete word 2 in ARINC Label 271 has the following bit assignment. Table 1-59 is applicable for all LCR-100 systems, except of P/N 145130-6002, -6200, -7001, -7011, -7100 and -7110.

Bit No.	Function	Bit Status	
		1	0
1 - 8	Label		
9 - 10	SDI		
11	Not used; always 0		
12	Normal Acceleration Warn	Warn	Normal
13	Fan Monitor	Fail	Normal / No Fan
14	Heading Warn Discrete	Warn	Normal
15	Attitude Warn Discrete	Warn	Normal
16	Yaw Rate Warn / Basic Mode (1) (2)	Warn/Basic	Normal
17	System Warn Discrete	Warn	Normal
18 - 20	Main Mode	refer to Table 1-60	
21	Turn Rate Warn Discrete	Warn	Normal
22	MSU Unavailable (3)	Unavailable / Not installed	Available
23	Magnetic Field Strength Status	Low	Normal
24 - 29	Not used; always 0		
30 - 31	SSM		
32	Parity (odd)		

Table 1-59 System Discrete Word 2 (Label 271)(all LCR-100 versions, except 145130-6002, -6200, -7001 and -7100)

1) LCR-100 Systems with P/N 145130-1xxx, -3000 and -6xxx: Basic Mode Discrete
   LCR-100 Systems with P/N 145130-2xxx and 145130-7xxx: Yaw Rate Warn Discrete
2) LCR-100 Systems with P/N 145130-1xxx and -3000: Always 0 in IRS operation.
3) Bit is not set (0) in case of MSU unavailable and DG Mode active

Bit			Status
20	19	18	
0	0	0	Startup
0	0	1	Static Alignment
0	1	0	Moving Alignment
0	1	1	Normal Operation
1	0	0	MSU Calibration
1	0	1	Test Mode

Table 1-60 Main Mode Bit Assignment (from Table 1-59)

Note: Bits 12, 14, 15, 16 and 21 reflect the status of the analog output discretes of the synchro interface module. These bits are not intended to be used in digital system versions.

Label 271

The system discrete word 2 in ARINC Label 271 has the following bit assignment. Table 1-61 is only applicable for LCR-100 systems with P/N 145130-6002, -6200, -7001, -7011, -7100 and -7110.

Bit No.	Function	Bit Status	
		1	0
1 - 8	Label		
9 - 10	SDI		
11	Not used; always 0		
12	Normal Acceleration Warn	Warn	Normal
13	Fan Monitor	Fail	Normal / No Fan
14	Heading Warn Discrete	Warn	Normal
15	Attitude Warn Discrete	Warn	Normal
16	Yaw Rate Warn	Warn	Normal
17	System Warn Discrete	Warn	Normal
18	DG Mode Discrete	DG Mode	Slaved Mode
19 - 20	Not used; always 0		
21	Turn Rate Warn Discrete	Warn	Normal
22	MSU Unavailable (1)	Unavailable / Not installed	Available
23	Magnetic Field Strength Status	Low	Normal
24 - 25	Not used; always 0		
26 - 28	Main Mode	refer to Table 1-62	
29	Not used; always 0		
30 - 31	SSM		
32	Parity (odd)		

Table 1-61 System Discrete Word 2 (Label 271)(only for LCR-100 versions with P/N 145130-6002, -6200, -7001 and -7100)

1) Bit is not set (0) in case of MSU unavailable and DG Mode active

Main Mode			
Bit			Status
28	27	26	
0	0	0	Startup
0	0	1	Static Alignment
0	1	0	Moving Alignment
0	1	1	Normal Operation
1	0	0	MSU Calibration
1	0	1	Test Mode

Table 1-62 Main Mode Bit Assignment (from Table 1-61)

Note: Bits 12, 14, 15, 16 and 21 reflect the status of the analog output discretes of the synchro interface module.

Label 274

The hybrid status word in ARINC Label 274 has the following bit assignment. Table 1-63 is not applicable for LCR-100 P/N 145130-1002 and -1005. For this systems refer to Table 1-66.

Bit No.	Function	Bit Status	
		1	0
1 - 8	Label		
9 - 10	SDI		
11	Time Mark 1 Availability Status	not available	available
12	Time Mark 2 Availability Status	not available	available
13	Hybrid Performance Status	degraded	normal
14	RAIM Availability Status	not available	available
15 - 16	Secondary GPSSU Validity	refer to Table 1-64	
17 - 18	Primary GPSSU Validity	refer to Table 1-64	
19	GPSSU Source	Secondary	Primary
20 - 23	Number of Satellites Tracked (LSB Bit 20)		
24 - 25	Not used, always 0 (Applicable to all LCR-100 versions except P/N 145130-3000 (see below))		
24	IDM parameters Availability Status (GNSS 1) (Applicable to 145130-3000 only)	not available	available
25	IDM parameters Availability Status (GNSS 2) (Applicable to 145130-3000 only)	not available	available
26 - 28	Hybrid Operational Mode	refer to Table 1-65	
29	MSB of Satellite tracked (16)		
30 - 31	SSM		
32	Parity (odd)		

Table 1-63 Hybrid Status Word (Label 274)

Bit No.			Comment
18	**17**	**Primary GPSSU Validity**	
16	**15**	**Secondary GPSSU Validity**	
0	0	Valid	Initialization, Acquisition, Navigation or Altitude Aiding Mode of GNSS, Aiding, GBAS, SBAS
0	1	Inactive	No Bus Activity
1	0	Functional Test	Self Test Mode
1	1	Fail	Fault Mode, Reserved

Table 1-64 GPSSU Validity

Bit No.			Hybrid Operational Mode
28	**27**	**26**	
0	0	0	GNSS communication missing
0	0	1	Initialization Mode
0	1	0	Stationary Alignment
0	1	1	Moving Alignment
1	0	0	Full Hybrid Navigation
1	0	1	Free Inertial Navigation
1	1	0	Horizontal Augmented Navigation
1	1	1	Vertical Augmented Navigation

Table 1-65 Hybrid Operational Modes

Label 274

The hybrid status word in ARINC Label 274 has the following bit assignment. Table 1-66 is only applicable for LCR-100 P/N 145130-1002 and -1005. For all other Systems refer to Table 1-63.

Bit No.	Function	Bit Status	
		1	0
1 - 8	Label		
9 - 10	SDI		
11-12	Not used, always 0		
13	RAIM Availability Status	available	not available
14	Time Mark 2 Availability Status	available	not available
15	Time Mark 1 Availability Status	available	not available
16	Hybrid Performance Status	normal	degraded
17 - 19	Hybrid Operational Mode	refer to Table 1-68	
20 - 21	Secondary GPSSU Validity	refer to Table 1-67	
22 - 23	Primary GPSSU Validity	refer to Table 1-67	
24	GPSSU Source	Primary	Secondary
25 - 28	Number of Satellites Tracked (LSB Bit 25)		
29	MSB of Satellite tracked (16)		
30 - 31	SSM		
32	Parity (odd)		

Table 1-66 Hybrid Status Word (Label 274)
Only applicable for LCR-100 P/N 145130-1002 and -1005.

Bit No.			Comment
23	22	Primary GPSSU Validity	
21	20	Secondary GPSSU Validity	
0	0	Fail	Fault Mode, Reserved
0	1	Functional Test	Self Test Mode
1	0	Inactive	No Bus Activity
1	1	Valid	Initialization, Acquisition, Navigation or Altitude Aiding Mode of GNSS, Aided, GBAS, SBAS

Table 1-67 GPSSU Validity
Only applicable for LCR-100 P/N 145130-1002 and -1005.

Bit No.			Hybrid Operational Mode
19	18	17	
0	0	0	GNSS communication missing
0	0	1	Initialization Mode
0	1	0	Stationary Alignment
0	1	1	GNSS Moving Alignment
1	0	0	Free Inertial Navigation
1	0	1	not used
1	1	0	not used
1	1	1	Hybrid Navigation

Table 1-68 Hybrid Operational Modes
Only applicable for LCR-100 P/N 145130-1002 and -1005.

Label 303

The input discrete word 1 in ARINC Label 303 indicates the following status of program pins:

Bit No.	Function	Bit Status	
		1	0
1 - 8	Label		
9 - 10	SDI		
11 - 13	Not used, always 0		
14	Mounting Position No. 1	Enabled	Disabled
15	Mounting Position No. 2	Enabled	Disabled
16	SDI 1	Enabled	Disabled
17	SDI 2	Enabled	Disabled
18	Parity	Enabled	Disabled
19	DG Mode Logic Select	Enabled	Disabled
20	Yaw/Rate SF Select 1 (1) / DADS Select 1 (2)	Enabled	Disabled
21	Yaw/Rate SF Select 2 (1) / DADS Select 2 (2)	Enabled	Disabled
22	ARINC Turn Rate Select	Enabled	Disabled
23	Ground/Air Logic Select	Enabled	Disabled
24	MSU Excitation Voltage Select	Enabled	Disabled
25	ARINC Update Rate Select	Enabled	Disabled
26 - 29	Not used, always 0		
30 - 31	SSM		
32	Parity (odd)		

Table 1-69 Input Discrete Word 1 (Label 303)

1) Only applicable for systems with installed Synchro Interface Module (LCR-100 P/N 145130-2xxx and -7xxx)
2) Only applicable for systems without Synchro Interface Module (LCR-100 P/N 145130-1xxx, -3000 and -6xxx)

Label 304

The input discrete word 2 in ARINC Label 304 indicates the following status of the control discrete input:

Bit No.	Function	Bit Status	
		1	0
1 - 8	Label		
9 - 10	SDI		
11 - 13	Not used, always 0	-	-
14	Test Mode	Enabled	Disabled
15	Command Interface Select	Enabled	Disabled
16	Selftest Data Enable	Enabled	Disabled
17 - 18	Not used, always 0	-	-
19	DG/MAG Mode Select	Enabled	Disabled
20	MSU Calibration	Enabled	Disabled
21	Slew Left	Enabled	Disabled
22	Slew Right	Enabled	Disabled
23	On Ground / In Air	On Ground	In Air
24	Normal Acceleration Test	Enabled	Disabled
25	Attitude Mode (1)	Selected	Not selected
26	Gyrocompass Mode Select	Enabled	Disabled
27	Stored Heading Alignment	Enabled	Disabled
28	Synchro True/Mag HDG Select	Enabled	Disabled
29	Not used, always 0	-	-
30 - 31	SSM		
32	Parity (odd)		

Table 1-70 Input Discrete Word 2 (Label 304)

1) Not applicable to LCR-100 P/N 145130-6xxx and -6xxx (always 0)

Label 350

Maintenance discrete word 1 in ARINC Label 350: Refer to Table 3-7 in section 3

Label 351

Maintenance discrete word 2 in ARINC Label 351: Refer to Table 3-8 in section 3

Label 352

Maintenance discrete word 3 in ARINC Label 352: Refer to Table 3-9 in section 3

Label 353

Maintenance discrete word 4 in ARINC Label 353: Refer to Table 3-10 in section 3

Label 356

The system input status word in ARINC Label 356 has the following bit assignment:

Bit No.	Function	Bit Status	
		1	0
1-8	Label		
9-10	SDI		
11-13	Not used, always 0	-	-
14	DADS Input 1	Inactive	Active
15	DADS Input 2	Inactive	Active
16	GNSS Input 1	Inactive	Active
17	GNSS Input 2	Inactive	Active
18	FMS / CDU Input 1	Inactive	Active
19	FMS / CDU Input 2	Inactive	Active
20	IDM Status	Failure	Normal
21	Fan Status	Warn	Normal
22	Time Mark A	Inactive	Active
23	Time Mark B	Inactive	Active
24-29	Not used, always 0	-	-
30-31	SSM		
32	Parity (odd)		

Table 1-71 System Input Status Word (Label 356)

The status of the ARINC 429 input port is set active for 2 seconds if a related input Label (refer to section 1, paragraph 4.3.1.1) is detected on the port. If a continuous data stream is provided to the port, the indication will remain active.

4.3.2.1.6 DITS Status Indication

The system sets the DITS SSM values of the AHRS data depending on the operation mode:

Label	Parameter	Format	Alignment Mode	Attitude Mode (AHRS operation)	Navigation Mode (P/N -1xxx, -2xxx and -3000 only)	Realignment Mode (P/N -1xxx, -2xxx and -3000 only)	MSU Calibration Mode	Maintenance Test Mode	Self-test
040	Body Turn Rate	BNR	NCD/Norm. (1)	Norm.	Norm.	Norm.	Norm.	NCD	TST
046	Software Version	BCD	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
151	System Discrete Word 4	DIS	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
152	System Discrete Word 5	DIS	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
155	Config. Discrete Word 1	DIS	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
156	Config. Discrete Word 2	DIS	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
270	System Discrete Word 1	DIS	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
271	System Discrete Word 2	DIS	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
272	System Discrete Word 3	DIS	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.

Label	Parameter	Format	Alignment Mode	Attitude Mode (AHRS operation)	Navigation Mode (P/N -1xxx, -2xxx and -3000 only)	Realignment Mode (P/N -1xxx, -2xxx and -3000 only)	MSU Calibration Mode	Maintenance Test Mode	Self-test
275	Command Discrete	DIS	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
300	Magnetic Sensor Input	BNR	NCD/ Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
301	Body Normal Accel.	BNR	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	TST
302	System Time	BNR	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
303	Input Discrete Word 1	DIS	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
304	Input Discrete Word 2	DIS	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
305	Alignment Countdown	BNR	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
306	MSU Fieldstrength	BNR	NCD/ Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
314	True Heading	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
320	Mag Heading	BNR	NCD	Norm. (2)	Norm.	Norm.	NCD/Norm.	NCD	TST
324	Pitch Angle	BNR	NCD/Norm. (1)	Norm.	Norm.	Norm.	NCD/Norm.	NCD	TST
325	Roll Angle	BNR	NCD/Norm. (1)	Norm.	Norm.	Norm.	NCD/Norm.	NCD	TST
326	Body Pitch Rate	BNR	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	TST
327	Body Roll Rate	BNR	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	TST
330	Body Yaw / Turn Rate	BNR	NCD/Norm.(3)	Norm.	Norm.	Norm.	Norm.	NCD	TST
331	Body Long. Accel.	BNR	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	TST
332	Body Lat. Accel.	BNR	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	TST
333	Body Normal Accel.	BNR	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	TST
334	Magnetic Sensor Input	BNR	NCD/Norm	Norm.	Norm.	Norm.	Norm.	NCD	TST
336	Pitch Att. Rate	BNR	NCD/Norm.(1)	Norm.	Norm.	Norm.	NCD	NCD	TST
337	Roll Att. Rate	BNR	NCD/Norm.(1)	Norm.	Norm.	Norm.	NCD	NCD	TST
340	Turn / Body Yaw Rate	BNR	NCD/Norm.(3)	Norm.	Norm.	Norm.	Norm.	NCD	TST
350	Mainten. Discr. Word 1	DIS	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
351	Mainten. Discr. Word 2	DIS	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
352	Mainten. Discr. Word 3	DIS	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
353	Mainten. Discr. Word 4	DIS	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
354	MSU Cal. Error	BNR	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
356	System Input Status Word	DIS	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.
361	Inertial Altitude	BNR	NCD	Norm.	Norm.	Norm.	NCD	NCD	TST
364	Vertical Accel.	BNR	NCD/ Norm.(1)	Norm.	Norm.	Norm.	Norm.	NCD	TST
365	Inert. Vert. Speed	BNR	NCD	Norm.	Norm.	Norm.	NCD	NCD	TST
375	Along Hdg. Accel.	BNR	NCD/ Norm.(1)	Norm.	Norm.	Norm.	Norm.	NCD	TST
376	Cross Hdg. Accel.	BNR	NCD/ Norm.(1)	Norm.	Norm.	Norm.	Norm.	NCD	TST
377	Equipm. Identification	BCD	Norm.	Norm.	Norm.	Norm.	Norm.	NCD	Norm.

Table 1-72 SSM Indication of AHRS Data depending on System Mode

1) Attitude and Attitude Rates are set valid when attitude alignment is completed.

2) NCD if MAG mode is active and MSU is not available (Not connected).

3) If Body Yaw Rate selected always set to NORM, if Turn Rate selected set to NORM when attitude alignment is completed.

The system sets the DITS SSM values of the IRS data depending on the operation mode as defined in the following table. The IRS data output is only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000).

Label	Parameter	Format	Alignment Mode	Attitude Mode (AHRS operation)	Navigation Mode	Realignment Mode	MSU Calibration Mode	Maintenance Test Mode	Self test
147	Magnetic Variation	BNR	NCD/Norm.(1)	NCD/Norm.(2)	Norm.	Norm.	NCD	NCD	TST
310	Present Pos Lat	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
311	Present Pos Long	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
312	Ground Speed	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
313	Track Angle True	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
315	Wind Speed	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
316	Wind Direct True	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
317	Track Angle (Mag)	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
321	Drift Angle	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
322	Flight Path Angle	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
323	Flight Path Accel	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
335	Track Angle Rate	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
360	Potential Vert Spd	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
362	Along Tk Hrz Accel	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
363	Cross Tk Hrz Accel	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
366	N-S Velocity	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
367	E-W Velocity	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
372	Wind Direction Magnetic	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
373	N-S Vel. Mag	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST
374	E-W Vel. Mag	BNR	NCD	NCD	Norm.	Norm.	NCD	NCD	TST

Table 1-73 SSM Indication of IRS Data depending on System mode

1) Set to normal operation when valid latitude and longitude is input
2) Set to normal operation if GNSS position is available

The system sets the DITS SSM values of the hybrid data depending on the operation mode as defined in the following table. The hybrid data output is only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000, except P/N 145130-1001).

Label (1)	Parameter	Format	Alignment Mode	Attitude Mode (AHRS operation)	Navigation Mode	Realignment Mode	MSU Calibration Mode	Maintenance Test Mode	Self-test
055	Hybrid Mag Heading	BNR	NCD	Norm.(2)	Norm.(2)	Norm.(2)	NCD	NCD	TST
104/315	Hybrid Wind Speed	BNR	NCD	Norm.(2)	Norm.(2)	Norm.(2)	NCD	NCD	TST
105/316 (1)	Hybrid Wind Direction True	BNR	Norm.	Norm.(2)	Norm.(2)	Norm.(2)	NCD	NCD	Norm.
106/372 (1)	Hybrid Wind Direction Mag	BNR	Norm.	Norm.(2)	Norm.(2)	Norm.(2)	NCD	NCD	Norm.

Label (1)	Parameter	For-mat	Align-ment Mode	Attitude Mode (AHRS op-eration)	Naviga-tion Mode	Realign-ment Mode	MSU Cali-bration Mode	Mainte-nance Test Mode	Self-test
132	Hybrid True Heading	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
134	Hybrid Potential Vert Spd	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
135	Hybrid Vertical FOM	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
137	Hybrid Track Angle	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
153/317 (1)	Hybrid Track Angle Mag	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
154/335 (1)	Hybrid Track Angle Rate	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
160/321 (1)	Hybrid Drift Angle	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
175/312 (1)	Hybrid Ground Speed	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
254	Hybrid Latitude	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
255	Hybrid Longitude	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
256	Hybrid Latitude Fine	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
257	Hybrid Longitude Fine	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
261	Hybrid Altitude (MSL)	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
262/323 (1)	Hybrid Flight Path Accel.	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
263	Hybrid Flight Path Angle	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
264	Hybrid Horizontal FOM	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
265	Hybrid Predicted Horizontal FOM	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
266	Hybrid N-S Velocity True	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
267	Hybrid E-W Velocity True	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
274	Hybrid Status	DIS	Norm.	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	Norm.
344	Hybrid Along HDG Velocity	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
345	Hybrid Vertical Velocity	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
346	Hybrid Across HDG Velocity	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
373/366 (1)	Hybrid N-S Velocity Mag	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST
374/367 (1)	Hybrid E-W Velocity Mag	BNR	NCD	Norm. (2)	Norm. (2)	Norm. (2)	NCD	NCD	TST

Table 1-74 SSM Indication of Hybrid and GNSS Data depending on System Mode

1) If a second Label number is mentioned this is applicable to LCR-100 system with P/N 145130-1002 and -1005

2) Set to normal if hybrid operational mode is in one of the navigation sub modes as defined in Table 1-65 (applicable for all LCR-100 systems except P/N 145130-1002 and -1005) and Table 1-68 (applicable for LCR-100 system with PN 145130-1002 and -1005).
Invalid if the following limits of estimated hybrid accuracy are exceeded (Only applicable for LCR-100 Systems with P/N- 1002 and -1005)

- velocity > 1 m/s, or
- position > 66 m or
- heading > 5 degree or

if the elapsed time without valid GNSS data exceeds 600 sec.

Augmentation Data

The following table shows required augmentation data to achieve valid AHRS data output during normal operation:

Label	Parameter	Format	MSU	DADS Pressure Altitude	DADS TAS	GNSS Horizontal Data (Table 1-78)	GNSS Vertical Data (Table 1-79)
040	Body Turn Rate	BNR					
046	Software Version	BCD					
151	System Discrete Word 4	DIS					
152	System Discrete Word 5	DIS					
155	Configuration Discrete Word 1	DIS					
156	Configuration Discrete Word 2	DIS					
270	System Discrete Word 1	DIS					
271	System Discrete Word 2	DIS					
272	System Discrete Word 3	DIS					
275	Command Discrete	DIS					
300	Magnetic Sensor Input	BNR	X				
301	Body Normal Accel.	BNR					
302	System Time	BNR					
303	Input Discrete Word 1	DIS					
304	Input Discrete Word 2	DIS					
305	Alignment Countdown	BNR					
306	MSU Fieldstrength	BNR	X				
314	True Heading	BNR					
320	Mag Heading	BNR	X (1)				
324	Pitch Angle	BNR					
325	Roll Angle	BNR					
326	Body Pitch Rate	BNR					
327	Body Roll Rate	BNR					
330	Body Yaw/ Turn Rate	BNR					
331	Body Long. Accel.	BNR					
332	Body Lat. Accel.	BNR					
333	Body Normal Accel.	BNR					
334	Magnetic Sensor Input	BNR					
336	Pitch Att. Rate	BNR					
337	Roll Att. Rate	BNR					
340	Turn / Body Yaw Rate	BNR					
350	Maintenance Discrete Word 1	DIS					
351	Maintenance Discrete Word 2	DIS					
352	Maintenance Discrete Word 3	DIS					
353	Maintenance Discrete Word 4	DIS					
354	MSU Cal. Error	BNR					
356	System Input Status	DIS					
361	Inertial Altitude	BNR		X			
364	Vertical Accel.	BNR					
365	Inert. Vert. Speed	BNR		X			
375	Along Hdg. Accel.	BNR					
376	Cross Hdg. Accel.	BNR					
377	Equipment Identification	BCD					

Table 1-75 Required Augmentation Data for valid AHRS Data Output

1) When operated in Attitude MAG mode

The following table shows required augmentation data to achieve valid IRS data output during normal operation:

Label	Parameter	Format	MSU	DADS Pressure Altitude	DADS TAS	GNSS Horizontal Data (Table 1-78)	GNSS Vertical Data (Table 1-79)
147	Magnetic Variation	BNR					
310	Present Pos Lat	BNR					
311	Present Pos Long	BNR					
312	Ground Speed	BNR					
313	Track Angle True	BNR					
315	Wind Speed	BNR			X		
316	Wind Direct True	BNR			X		
317	Track Angle Mag	BNR					
321	Drift Angle	BNR					
322	Flight Path Angle	BNR		X			
323	Flight Path Accel	BNR		X			
335	Track Angle Rate	BNR					
360	Potential Vert Speed	BNR		X			
362	Along Trk Horiz. Accel	BNR					
363	Cross Trk Horiz. Accel	BNR					
366	N-S Velocity	BNR					
367	E-W Velocity	BNR					
372	Wind Direction Mag	BNR			X		
373	N-S Vel. Mag	BNR					
374	E-W Vel. Mag	BNR					

Table 1-76 Required Augmentation Data for valid IRS Data Output

The following table shows required augmentation data to achieve valid hybrid data output during normal operation:

Label (1)	Parameter	Format	MSU	DADS Pressure Altitude	DADS TAS	GNSS Horizontal Data (Table 1-78)	GNSS Vertical Data (Table 1-79)
055	Hybrid Mag Heading	BNR				X	
104/315 (1)	Hybrid Wind Speed	BNR			X	X	
105/316 (1)	Hybrid Wind Direction True	BNR			X	X	
106/372 (1)	Hybrid Wind Direction Mag	BNR			X	X	
132	Hybrid True Heading	BNR				X	
134	Hybrid Potential Vert Speed	BNR		X		X	
135	Hybrid Vertical FOM	BNR					X
137	Hybrid Track Angle	BNR				X	
153/317 (1)	Hybrid Track Angle Mag	BNR				X	
154/335 (1)	Hybrid Track Angle Rate	BNR				X	
160/321 (1)	Hybrid Drift Angle	BNR				X	
175	Hybrid Ground Speed	BNR				X	
254	Hybrid Latitude	BNR				X	

Label (1)	Parameter	For-mat	MSU	DADS Pressure Altitude	DADS TAS	GNSS Hori-zontal Data (Table 1-78)	GNSS Ver-tical Data (Table 1-79)
255	Hybrid Longitude	BNR				X	
256	Hybrid Latitude Fine	BNR				X	
257	Hybrid Longitude Fine	BNR				X	
261	Hybrid Altitude (MSL)	BNR					X
262/323 (1)	Hybrid Flight Path Accel.	BNR		X		X	
263	Hybrid Flight Path Angle	BNR		X		X	
264	Hybrid Horizontal FOM	BNR				X	
265	Hybrid Predicted Horizontal FOM	BNR				X	
266	Hybrid N-S Velocity True	BNR				X	
267	Hybrid E-W Velocity True	BNR				X	
274	Hybrid Status	DIS				X (2)	
344	Hybrid Along HDG Velocity	BNR				X	
345	Hybrid Vertical Velocity	BNR					X
346	Hybrid Across HDG Velocity	BNR				X	
373	Hybrid N-S Velocity Mag	BNR				X	
374	Hybrid E-W Velocity Mag	BNR				X	

Table 1-77 Required Augmentation Data for valid Hybrid Data Output

1) If a second Label number is mentioned this is applicable to LCR-100 system with P/N 145130-1002 and -1005

2) Only applicable for LCR-100 Systems with P/N 145130-1002, -1003 and -1005. For Systems with P/N 145130-1000, -2xxx and -3000 Label 274 is sent independent of the receipt of GNSS data.

The following table shows required horizontal GNSS augmentation data.

Label	Parameter	Note
101	HDOP	
110	GNSS Latitude	
111	GNSS Longitude	
120	GNSS Latitude Fine	
121	GNSS Longitude Fine	
130	Horizontal Integrity Limit	Not required for LCR-100 System P/N 145130-1002 and -1005
150	UTC	Not required for LCR-100 System P/N 145130-1002 and -1005
166	N/S Velocity	
174	E/W Velocity	
247	Horizontal FOM	
260	Date	Not required for LCR-100 System P/N 145130-1002 and -1005
273	GNSS Sensor Status	
377	Equipment ID	Not required for LCR-100 System P/N 145130-1002 and -1005

Table 1-78 Horizontal GNSS Augmentation data

The following table shows required vertical GNSS augmentation data.

Label	Parameter
076	GNSS Altitude (MSL)
102	VDOP
130	Horizontal Integrity Limit
133	Vertical Integrity Limit
136	Vertical FOM
150	UTC
165	Vertical Velocity
273	GNSS Sensor Status
377	Equipment ID

Table 1-79 Vertical GNSS Augmentation data

4.4 Analog Interfaces

4.4.1 Analog Input

4.4.1.1 Synchro Reference Input

This paragraph is only applicable for systems with installed synchro interface module (LCR-100 systems with P/N 145130-2xxx and -7xxx).

The synchro reference input accepts 26 VAC 400 Hz sinusoidal voltage with signal quality according "ED-14D / DO-160E: Environmental Conditions and Test Procedures for Airborne Equipment" section 16 scaled from 115 VAC to 26 VAC. This is equivalent to the scaling to 230 VAC defined in section 16.

The system has one Attitude Synchro Reference input used as reference for pitch and roll synchro outputs as well as for pitch and roll 2-Wire AC outputs.

The system has two Heading Synchro References (HDG1 and HDG2) inputs that are used as reference for the heading 1 respectively heading 2 synchro outputs.

All synchro reference inputs are AC coupled to the aircraft.

4.4.2 Analog Output

During system startup all analog outputs of the system remain zero.

4.4.2.1 Synchro Output

This paragraph is only applicable for systems with installed synchro interface module (LCR-100 systems with P/N 145130-2xxx and -7xxx).

The system outputs the synchro signals according ARINC 407-1 standard:

Output Signal	Range	D/A Resolution	Analog Conversion Accuracy	Index Reference	Positive Direction Sense	Scale Factor	Load Capability	Signal Format	Selftest Value
	[deg]	[Bit]	[deg] 95 %			[deg]	[Ohm]		[deg]
Pitch	± 180	16	0.3 0.5 (1)	0 deg = Horizon	Nose Up	1 = 1	3 Passive Synchro Receiver 120+j450	3 Wire	refer to Table 1-82
Roll	± 180	16	0.3 0.5 (1)	0 deg = Horizon	Right Wing Down	1 = 1	3 Passive Synchro Receiver 120+j450	3 Wire	refer to Table 1-82
Magnetic Heading 1	0-360	12	0.3 0.5 (1)	0 deg = Magnetic North	Nose Right	1 = 1	3 Passive Synchro Receiver 120+j450	3 Wire	refer to Table 1-82
Magnetic Heading 2	0-360	12	0.3 0.5 (1)	0 deg = Magnetic North	Nose Right	1 = 1	3 Passive Synchro Receiver 120+j450	3 Wire	refer to Table 1-82

Table 1-80 Synchro Outputs

1) Reduced accuracy outside the temperature range of -40 °C and + 55 °C.

NOTE

The indicated angle of a synchro output is defined by the ratio between the three synchro voltages independent of the absolute value of these voltages.

The synchro voltage outputs on the LCR-100 are sensitive to the applied load. The following figure shows a typical measurement of the general characteristic of the synchro output dependent on applied load in reference to the ARINC 407-1 standard (Angle 0°, at nominal reference input voltage of 26VAC). The shown values have a maximum tolerance of +/-3%.

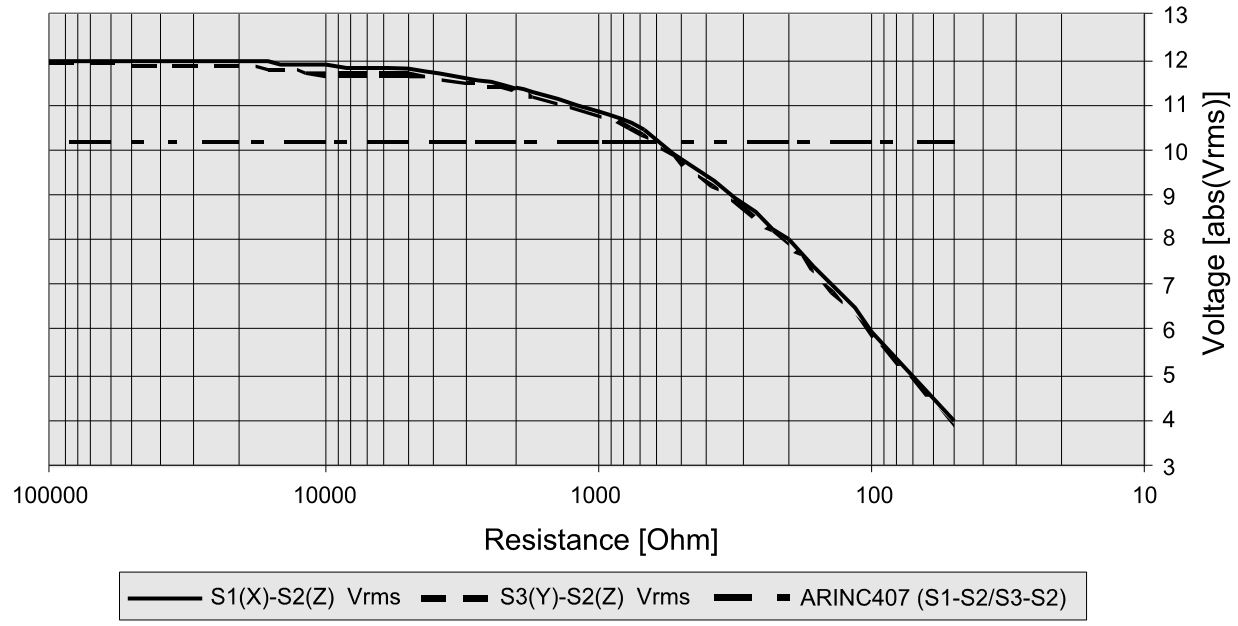


Figure 1-6 Synchro Output Voltage as Function of Synchro Load

4.4.2.2 2 Wire AC Output

This paragraph is only applicable for systems with installed synchro interface module (LCR-100 systems with P/N 145130-2xxx and -7xxx).

The system outputs the 2 Wire AC signals as defined in the following table:

Output Signal	Range	D/A Resolution	Analog Conversion Accuracy	Index Reference	Positive Direction Sense	Scale Factor (3)	Load Capability	Signal Format	Selftest Value
	[deg]	[Bit]	[deg] 95 % at 20 deg			[mV/deg] at 20 deg	[kOhm]		[deg]
Pitch Two Wire	± 90	16	0.5	0 V = Horizon	Nose Up	50	< 10	2 Wire AC (1)	refer to Table 1-82
Roll Two Wire	± 90	16	0.5	0 V = Horizon	Right Wing Down	50	< 10	2 Wire AC (1)	refer to Table 1-82
Pitch Two Wire	± 90	16	0.5	0 V = Horizon	Nose Up	200 167 (2)	< 5	2 Wire AC (1)	refer to Table 1-82
Roll Two Wire	± 90	16	0.5	0 V = Horizon	Right Wing Down	200 167 (2)	< 5	2 Wire AC (1)	refer to Table 1-82

Table 1-81 2 Wire AC Outputs

1) Positive sense out of phase with reference
2) 167 mV/deg for LCR-100 system with P/N 145130-7100 and -7110
3) Voltage values are RMS of the 400Hz AC output signal

4.4.2.3 DC Output

4.4.2.3.1 MAG Heading Slaving Error

This output is only applicable if a MSU is installed.

The MAG Heading Slaving Error output indicates the difference between the analytical platform heading and the Magnetic Sensor Heading Input.

The MAG Heading Slaving Error is a 2-wire DC current output.

The scale factor is + 13.3 µA/deg. The full scale of the output is ± 200 µA. That corresponds to an output range of ± 15°.

The output is filtered by software with a 1st order low pass filter with a time constant of 2.0 seconds. The sense of the output is:

Slaving Error = analytical platform heading - Magnetic Sensor Heading Input

The accuracy is ± 15 % of the full scale value. The maximum load resistance is 1 kOhm.

4.4.2.3.2 Yaw Rate DC Output

This paragraph is only applicable for systems with installed synchro interface module (LCR-100 systems with P/N 145130-2xxx and -7xxx).

The Yaw Rate DC Output is a 2-wire differential DC output.

The scale factor is selectable to 100, 200, 333 or 666 mV/deg/s by program pin setting (refer to section 1, paragraph 4.2.1.2, Table 1-22). The full scale of the output is ± 4 VDC. That corresponds to output ranges of ± 40, ± 20, ± 12 or ± 6 deg/s depending on program pin setting.

The output is filtered by software with an 8 Hz 2^{nd} order low pass filter. The output voltage for CW rate (nose right) is positive. The accuracy is ± 10 % of the full scale value. The maximum load resistance is 1 kOhm.

4.4.2.3.3 Turn Rate DC Output

This paragraph is only applicable for systems with installed synchro interface module (LCR-100 systems with P/N 145130-2xxx and -7xxx).

The Turn Rate DC Output is a 2-wire differential DC output.

The scale factor is 333 mV/deg/s. The full scale of the output is ± 4 VDC. That corresponds to an output range of ± 12 deg/s.

The output is filtered by software with a 1^{st} order low pass filter with a time constant of 0.9 seconds. The output voltage for CW rate (nose right) is positive. The accuracy is ± 10 % of the full scale value. The maximum load resistance is 1 kOhm.

4.4.2.3.4 Normal Acceleration DC Output

This paragraph is only applicable for systems with installed synchro interface module (LCR-100 systems with P/N 145130-2xxx and -7xxx).

The Normal Acceleration DC Output is referenced to the aircraft body coordinate system and is a 2-wire differential DC output.

The scale factor is + 383 mV/g. The full scale of the output is ± 3.83 VDC. That corresponds to an output range of ± 10 g.

The output is filtered by software with an 8 Hz 2^{nd} order low pass filter. The output voltage is positive for acceleration in upward direction. That means that if the aircraft is on ground and leveled the output will be + 383 mV corresponding to 1 g. The accuracy is ± 10 % of the full scale value. The maximum load resistance is 1 kOhm.

4.5 MSU (Flux Valve) Interface

The system provides a 400 Hz excitation voltage for the flux valve.

The system utilizes the three 800 Hz signals that are provided by the flux valve to calculate and/or determine a heading value and the horizontal magnetic field strength.

The system can be operated with two different types of flux valves: Sperry type and Bendix King type. They work with an excitation voltage of either 23.5 VAC (Honeywell/TECSTAR) or 12.5 VAC (Bendix King). The excitation voltage is adjustable to both flux valve types by the program pin MSU Excitation Voltage Select (refer to section 1, paragraph 4.2.1.2). The system is capable to process the signals of both flux valve types. The interconnection with both flux valve types is shown in Section 1, chapter 9.7, Table 1-90.

4.6 Test Interface

4.6.1 RS-422

The system provides two RS-422 asynchronous interfaces without hardware handshake with a minimum baud rate of 9600 Bd. One interface will be used for maintenance, test and calibration purposes and the other is currently not used.

4.6.2 RS-232

The system provides a RS-232 asynchronous interface without hardware handshake with a minimum baud rate of 9600 Bd for maintenance and test purposes.

NOTE

The interface may be operated using the Northrop Grumman LITEF GmbH LCR-100 Level 1 Maintenance Set.

4.6.3 Ethernet

The system provides one Ethernet interface 10/100 BaseT for maintenance and test purposes.

NOTE

The interface may be operated using the Northrop Grumman LITEF GmbH LCR-100 Level 1 Maintenance Set.

5 Selftest Outputs

5.1 Selftest Data Output on Ground

Functional selftest can be activated when aircraft is on ground and the selftest data discrete is activated. The digital selftest values are defined in Table 1-48, Table 1-49 and Table 1-50. The analog and discrete selftest outputs shall be as defined in Table 1-82 and Table 1-83.

	Output Signal	**Selftest Value**
Synchro and 2 wire AC Output	Magnetic Heading 1	15 deg
	Magnetic Heading 2	15 deg
	Pitch	+ 5 deg
	Roll	+ 45 deg
DC Voltage Output	Slaving Error	+ 15 deg
	Yaw Rate	+ 6 deg/s
	Turn Rate	+ 3 deg/s
	Normal Acceleration	+ 0.1 g

Table 1-82 Analog Selftest Outputs

	Output Signal	**Selftest Value**
Discrete Output	System Warn	System valid
	Basic Mode Annunciator (1) / Yaw Rate Warn (2)	Basic Mode set / Yaw Rate invalid
	ATT Mode Annunciator	Attitude Mode
	Autopilot Heading Interlock	Autopilot Heading invalid
	Attitude Warn	Attitude invalid
	Heading Warn 1	Heading 1 invalid
	Heading Warn 2	Heading 2 invalid
	Turn Rate Warn	Turn Rate invalid

Table 1-83 Discrete Selftest Outputs

1) Only applicable for systems without synchro interface module (LCR-100 P/N 145130-1xxx, -3000 and -6xxx)

2) Only applicable for systems with installed synchro interface module (LCR-100 P/N 145130-2xxx and -7xxx)

5.2 Normal Acceleration Test Enable

When the Normal Acceleration Test Enable Discrete (refer to section 1, paragraph 4.2.1.3) is set, the system sets the Normal Acceleration DC Output (refer to section 1, paragraph 4.4.2.3.1) to 0.0 VDC (= 0.0 g), independent on the Air/Ground status.

The selftest data command on ground supersedes the Normal Acceleration Test output.

6 Cooling Requirements

In order to improve system reliability, the AHRU mounting tray optionally incorporates an integral cooling fan. Increased reliability will result from operation with the optional cooling fan.

7 MSU (Flux Valve) Calibration Procedure

7.1 General Statements and Premises

An automatic MSU calibration procedure is implemented in the AHRU software, the procedure does not require any supporting equipment.

For LCR-100 Gyrocompass AHRS systems P/N 145130-1xxx, -2xxx and -3000 the MSU calibration mode can only be entered when the system operates in attitude mode and a MSU has been detected at power on.

The calibration mode will be activated by the MSU calibration discrete (refer to section 1, paragraph 4.2.1.3) or by the mode button if the alignment is completed and the aircraft is determined to be on ground (ground/air discrete is set for aircraft on ground), a MSU is detected at power on and no motion is detected. The commands of the mode button will be accepted when it is pressed continuously for more than 2 seconds. The MSU calibration mode is indicated by a continuous illuminating of the LED at the front plate of the system. If the LED flashes, this indicates a fault and it is not possible to enter MSU calibration mode.

The procedure must be performed in a position without local disturbances of the earth's magnetic field as no compensation for such disturbances can be made.

To ensure that all of the factors for which compensation is required are present, the procedure must be performed with the engine(s) running and all electrical systems used in flight are to be switched on. Particular attention should be paid to systems in the neighborhood of the MSU, strobe and/or position lights, pitot tube heating etc. When the procedure has been completed, both single and dual cycle magnetic disturbances produced by the aircraft and its systems are practically eliminated. The MSU Calibration Algorithm is able to compensate the MSU errors (sum of Single and dual cycle errors) of up to 12 degrees. A reference direction is not required. Any initial aircraft heading can be used.

When a new MSU is installed, an initial rough alignment may be made followed by the calibration procedure. When the procedure has been completed, the aircraft should be aligned with a reference direction and the MSU alignment adjusted until the residual index error is removed and the correct heading is indicated.

7.2 Compass Swing

The MSU Calibration Procedure requires execution of a compass swing.

It is recommended to perform the swing on a compass rose at the airport or alternatively using a calibrated master compass to align the aircraft during the swing.

During the compass swing procedure the aircraft is turned clockwise to eight different headings about 45° apart, a ± 5° error in spacing is acceptable. These headings are indicated on the appropriate system's primary heading indicator. The aircraft can be rotated about its vertical axis or taxied in a circle to align with the required headings.

The operator supervises the procedure via the aircraft instruments (HSI, RMI). The displayed heading and the heading flag are used to reach the 8 required headings and to

determine when the next heading change is to be made. Refer to the detailed procedure which follows this general description.

The calibration mode is selected by either the mode button switch on the front panel (by pressing it continuously for more than 2 seconds) of the LCR-100 AHRU or by setting the MSU Cal Discrete. If the Air/Ground discrete indicates that the aircraft is on the ground, the MSU calibration mode is engaged. If the Air/Ground discrete indicates that the aircraft is in the air, the normal attitude mode of operation remains selected. For discrete words refer to Table 1-70.

NOTE

If Electrical systems, which can only be switched on in the air, must remain off, the heading system may exhibit uncompensated errors during flight. A way should be found to switch them on without changing the "On Ground" indication to AHRU.

If the LED flashes, this indicates a fault and it is not possible to enter the MSU calibration mode.

As long as a heading change is less than 5° of the calibration mode's initial position, the displayed heading is the input received from the MSU. This enables manual checks on the input error for different headings.

When the heading change is 5° different from the initial procedure heading, the heading relative to the initial procedure heading is displayed. This means that headings do not have to be calculated by the ground crew, the next required heading is always the next multiple of 45° ± 5° (e.g. 45°, 90°, 135°, 180° etc.).

In each of the eight positions, including the initial position, the system accepts heading from the MSU. The time required for data collection depends on aircraft movements caused for example by wind or propeller rotation. During data collection and the turns between the heading positions the Heading Warn Flag is displayed. At the end of each data collection period the flag disappears to indicate that the turn to the next heading can be started.

If the flag does not disappear, it indicates that either the heading is outside the ± 5° tolerance or data has not been correctly collected because of excessive aircraft motion. In this case the procedure must be started again.

The Attitude Warn flag is displayed throughout the performance of the procedure.

After data has been collected for each of the eight headings, the system calculates the compensation factors and stores this data in the IDM. The IDM is attached to the AHRU mounting tray. AHRU replacement does not require a MSU calibration.

After the compensation factors have been calculated, the heading display is switched to an indication of the quality of the compensation available. The value indicated is the standard deviation of the residual error multiplied by 100. When the calibration was successful, the heading warn flag is removed from view on this display.

If the heading warn flag continues to be displayed, the procedure failed. The indicated results are not stored in the IDM and the last valid values are retained.

After a successful calibration, the system returns to normal mode by disabling the MSU calibration discrete. If the MSU calibration mode has been entered by the mode button (MSU calibration discrete disabled), the system returns to normal mode automatically 10 s after indication of the residual heading error or if the mode button has been activated again (continuously pressed for more than 2 s). All warning flags disappear and normal operation is resumed.

If the MSU CAL MODE is selected accidentally, the attitude warn flag is displayed during a ground run. The display of these flags should prevent flight with the switch in this position. However if the aircraft takes off despite the warning, the LCR-100 will use the previously stored compensation data when the unit senses the "in-air" state, ensuring that magnetic heading is valid while in the air. The heading will be as accurate as the previously stored MSU compensation data allows.

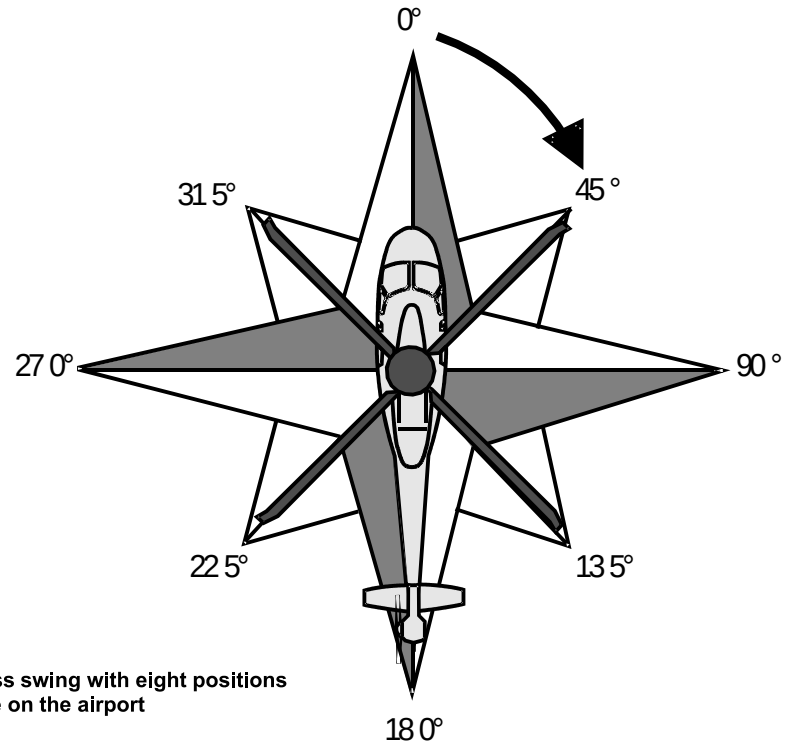


Figure 1-7 Compass Swing

7.3 Index Error Compensation Procedure

The index error of the MSU is not compensated by the automatic MSU calibration. There are two possibilities for inserting the index error correction in the MSU calibration mode:

(1) After a normal compass swing the index error can be compensated, or

(2) Only the index error can be compensated.

Procedure 1

- Set the System to MSU calibration mode (refer to section 2, paragraph 5.5)
- Perform a compass swing
- After the compass swing is completed, switch to DG and point the aircraft to some known heading (within ± 0.5 degrees)
- The HSI will now indicate the calibrated magnetic heading (Compass Swing Calibration) but without formerly stored index error correction.
- Use the slew left/right switch to set the desired heading (slew rate 0.3 deg/s, correction limited to ± 5.0 degrees) or use the Set Magnetic Heading Command ARINC Label 043 to enter the correction value numerically (1).
- When the desired heading is set, switch the System back to MAG (2).
- The HSI will now indicate the corrected heading.

Procedure 2

- Point the aircraft to some known heading (within ± 0.5 degrees).
- Set the system to MSU calibration mode (refer to section 2, paragraph 5.5).
- Switch to DG (if the system was set to DG before, switch to MAG and back to DG)
- The HSI will now indicate the calibrated magnetic heading (Compass Swing Calibration) but without formerly stored index error correction.
- Use the slew left/right switch to set the desired heading (slew rate 0.3 deg/s, correction limited to ± 5.0 degrees) or use the Set Magnetic Heading Command ARINC Label 043 to enter the correction value numerically (1).
- When the desired heading is set, switch the system back to MAG (2).
- The HSI will now indicate the corrected heading.

Notes

1) In the Index Error Correction (IEC) Mode the system accepts values from -5 deg to +5 deg on BCD ARINC label 043. Multiple entries will not be summed up. The last entered value will be utilized as Index Error Correction value.

2) A new IEC value will be stored only when the IEC Mode will be left by switching back from DG to MAG. If the IEC Mode is left by either switching off MSU Calibration Mode or by switching off system power a new IEC value will not be stored and the formerly stored value will be retained.

7.4 MSU Calibration Procedure/Checklist by using the MSU calibration discrete

Compass Swing

- ❑ Aircraft (A/C) in location with no external magnetic disturbances
- ❑ engine(s) running
- ❑ all electrical equipment switched on
- ❑ AHRS switched on
- ❑ alignment completed, all flags out of view
- ❑ Enable the MSU CAL MODE Discrete
- ❑ ATT Flag in view
- ❑ HDG Flag in view
- ❑ Initial HDG indication: _____
- ❑ HDG Flag disappears
- ❑ A/C to 45° indic. HDG
- ❑ HDG Flag in view
- ❑ HDG Flag disappears
- ❑ A/C to 90° indic. HDG
- ❑ HDG Flag in view
- ❑ HDG Flag disappears
- ❑ A/C to 135° indic. HDG
- ❑ HDG Flag in view
- ❑ HDG Flag disappears
- ❑ A/C to 180° indic. HDG
- ❑ HDG Flag in view
- ❑ HDG Flag disappears
- ❑ A/C to 225° indic. HDG
- ❑ HDG Flag in view
- ❑ HDG Flag disappears
- ❑ A/C to 270° indic. HDG
- ❑ HDG Flag in view
- ❑ HDG Flag disappears
- ❑ A/C to 315° indic. HDG
- ❑ HDG Flag in view
- ❑ HDG Flag disappears
- ❑ Indication of the residual error on compass: _____
- ❑ HDG Flag out of view
- ❑ ATT Flag out of view

If the index error shall be corrected continue with test steps listed in sub-paragraph "Index Error Correction" listed below.

Otherwise:

- ❑ disable the MSU CAL MODE Discrete

Index Error Correction

- ❑ Set A/C to Reference HDG
- ❑ Switch to DG
- ❑ Use slew left/right to set HDG (slew rate 0.3 deg/s) or set the correction value numerically by using the Set MAG HDG command (correction value limited to ± 5.0 degrees)
- ❑ Switch to MAG
- ❑ MSU CAL MODE "OFF"

7.5 MSU Calibration Procedure/Checklist by using the mode button on the AHRU

Compass Swing

- ❑ Aircraft (A/C) in location with no external magnetic disturbances
- ❑ engine(s) running
- ❑ all electrical equipment switched on
- ❑ AHRS switched on
- ❑ alignment completed, all flags out of view
- ❑ Press the Mode button on the AHRU until the red LED illuminates continuously
- ❑ ATT Flag in view
- ❑ HDG Flag in view
- ❑ Initial HDG indication: _____
- ❑ HDG Flag disappears
- ❑ A/C to 45° indic. HDG
- ❑ HDG Flag in view
- ❑ HDG Flag disappears
- ❑ A/C to 90° indic. HDG
- ❑ HDG Flag in view
- ❑ HDG Flag disappears
- ❑ A/C to 135° indic. HDG
- ❑ HDG Flag in view
- ❑ HDG Flag disappears
- ❑ A/C to 180° indic. HDG
- ❑ HDG Flag in view
- ❑ HDG Flag disappears
- ❑ A/C to 225° indic. HDG
- ❑ HDG Flag in view
- ❑ HDG Flag disappears
- ❑ A/C to 270° indic. HDG
- ❑ HDG Flag in view
- ❑ HDG Flag disappears
- ❑ A/C to 315° indic. HDG
- ❑ HDG Flag in view
- ❑ HDG Flag disappears
- ❑ Indication of the residual error on compass: _____
- ❑ If the index error shall be corrected switch to DG mode within 10s when the residual error is displayed and continue with test steps listed in sub-paragraph "Index Error Correction" listed below.

Otherwise:

- ❑ System switches back to Normal Mode automatically after 10s when the residual error is displayed

Index Error Correction

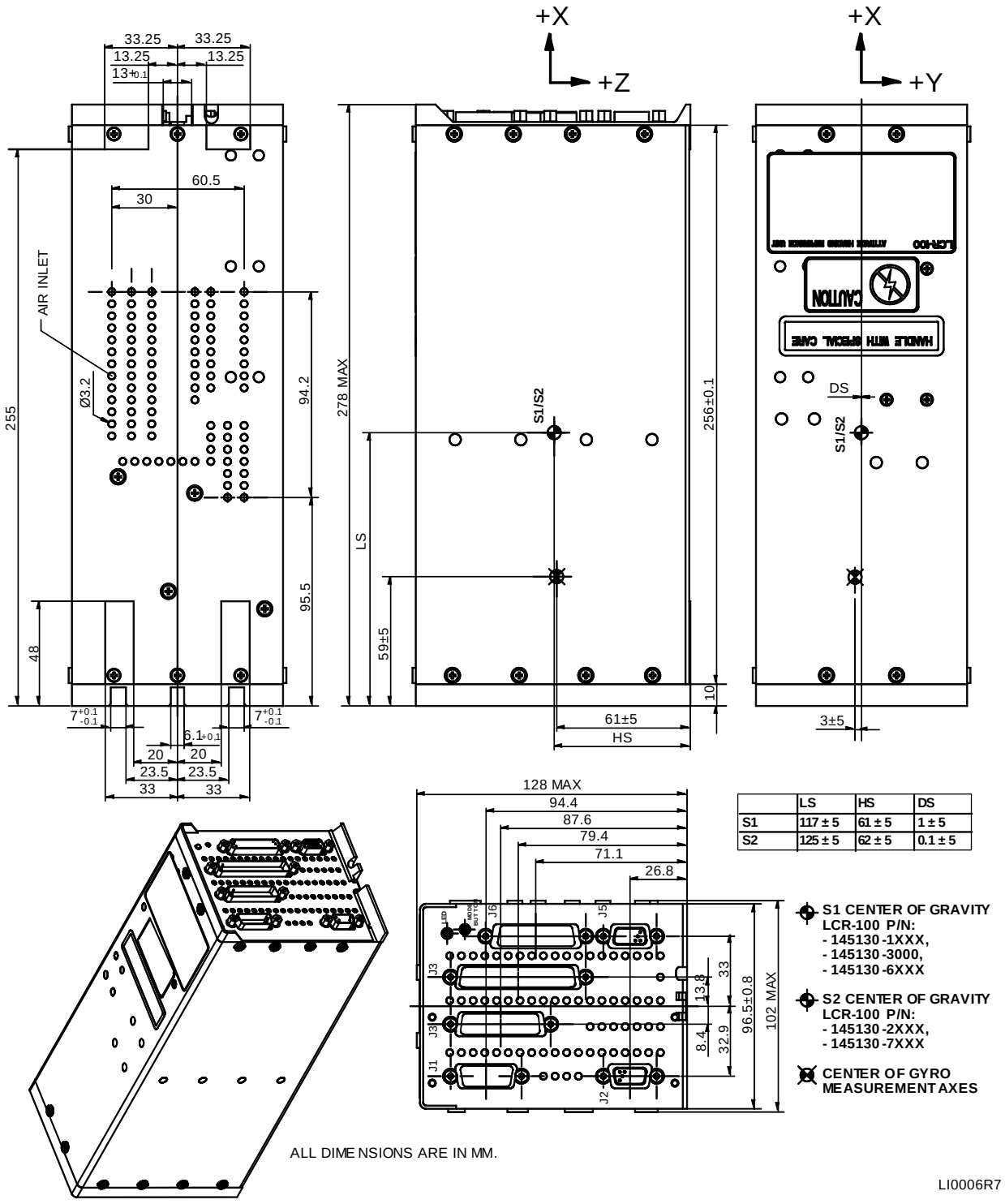
- ❑ Set A/C to Reference HDG
- ❑ Use slew left/right to set HDG (slew rate 0.3 deg/s) or set the correction value numerically by using the Set MAG HDG command (correction value limited to ± 5.0 degrees)
- ❑ Switch to MAG
- ❑ Systems switches back to Normal Mode automatically after 10s.

8 Outline Drawings

Component/Description	refer to Figure
AHRU	
AHRU (Outline Drawing LCR-100)	Figure 1-8
AHRU Front View	Figure 1-9
MSU - Magnetic Sensor Units	
MSU Bendix/King KMT 112	Figure 1-10
MSU Honeywell, TECSTAR FX-120/FX-600/FV-1	Figure 1-11
MSU Honeywell FX-125/220	Figure 1-12
CCU - Compass Control Unit	
CCU Outline and Mounting Diagram	Figure 1-13
Mounting Trays	
LCR-100 Mounting Tray, ruggedized without Fan	Figure 1-14
LCR-100 Mounting Tray, ruggedized with Fan	Figure 1-15
LCR-92/93 Mounting Tray, standard without Fan	Figure 1-16
LCR-92/93 Mounting Tray, standard with Fan	Figure 1-17
LCR-92/93 Mounting Tray, ruggedized without Fan	Figure 1-18
LCR-92/93 Mounting Tray, ruggedized with Fan	Figure 1-19
IDM - Installation Data Module	
IDM Outline Drawing	Figure 1-20

8.1 AHRU

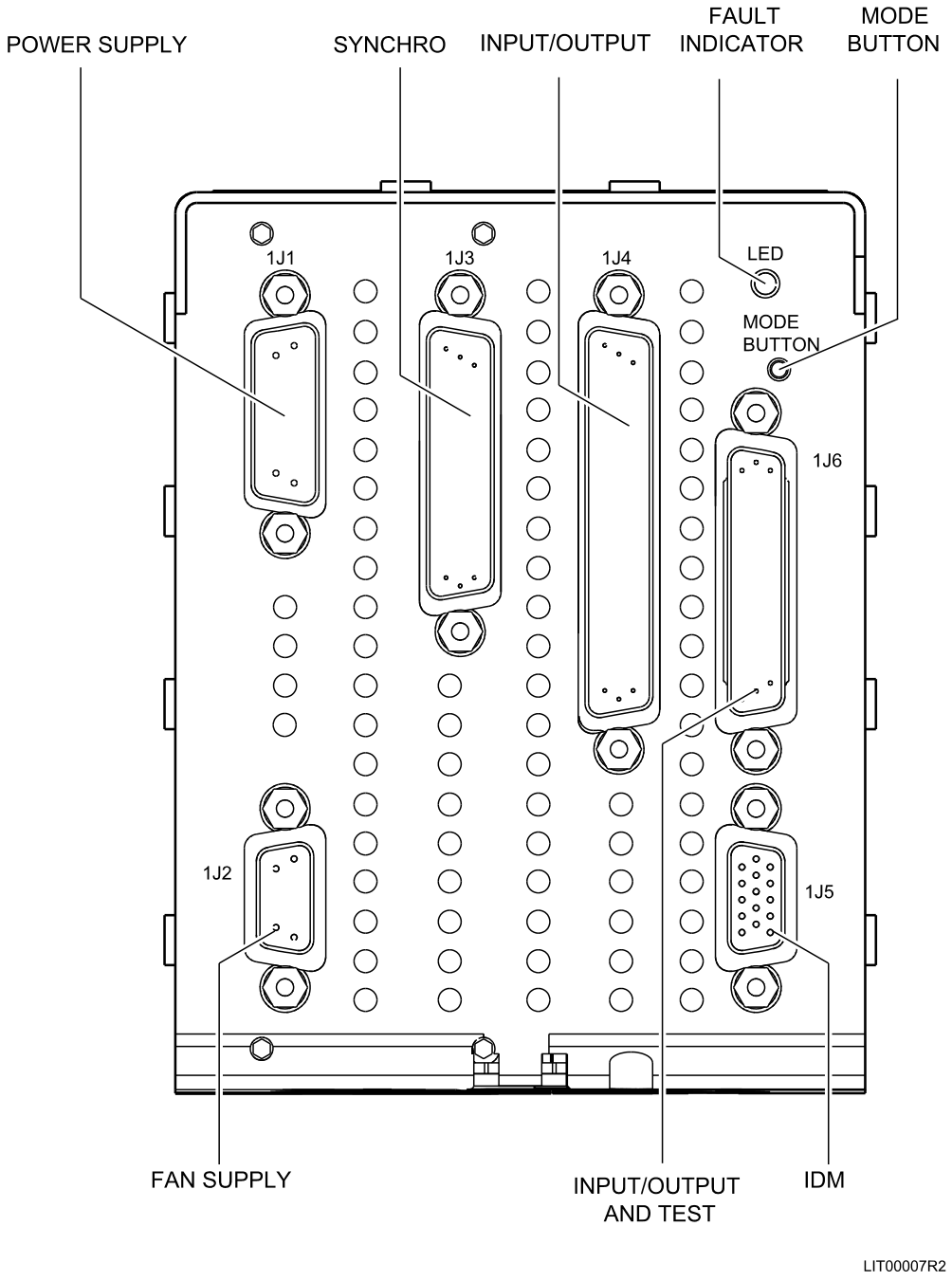
8.1.1 AHRU Outlines



	LS	HS	DS
S1	117 ± 5	61 ± 5	1 ± 5
S2	125 ± 5	62 ± 5	0.1 ± 5

Figure 1-8 AHRU Outline

8.1.2 AHRU Front View



Synchro Connector 1J3 is only available for systems with installed synchro interface module (LCR-100 P/N 145130-2xxx and -7xxx).

Figure 1-9 Front View of AHRU

8.2 Magnetic Sensor Units (MSU)

8.2.1 MSU, Bendix/King Outline

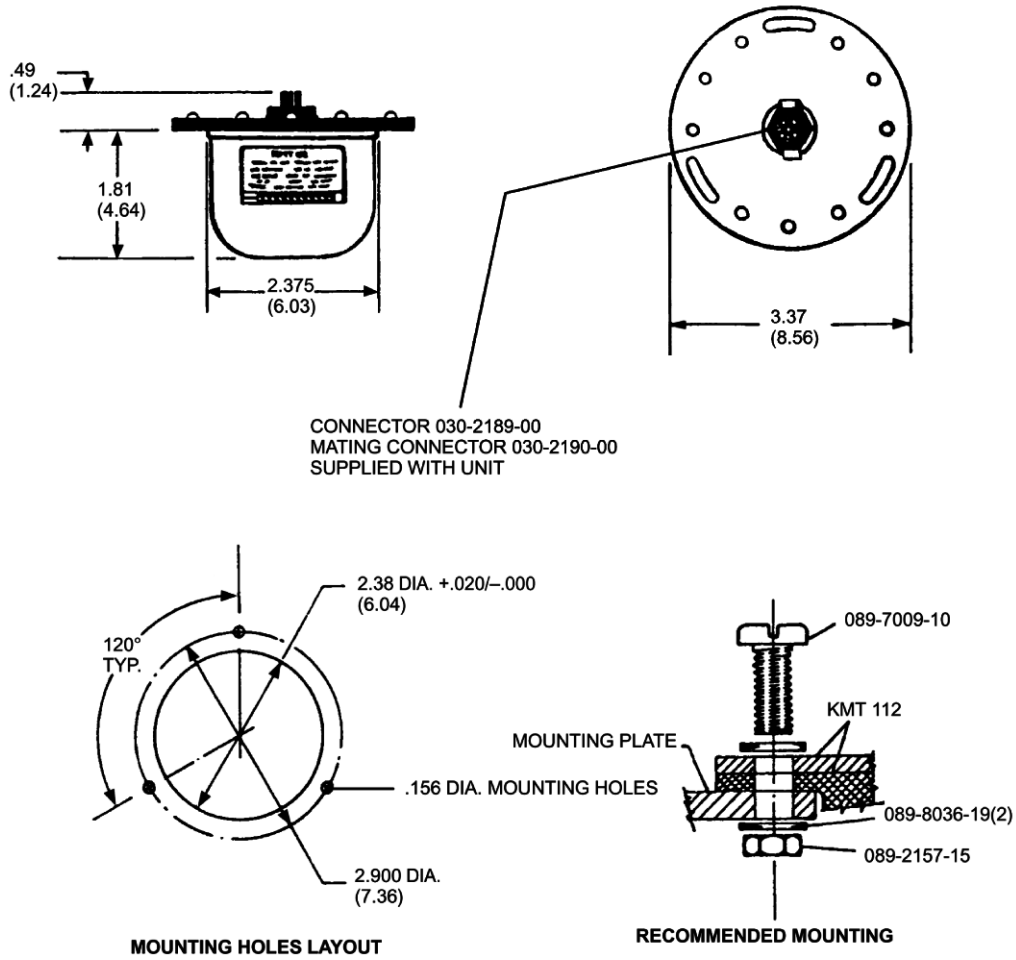


Figure 1-10 KMT 112 MSU Outline and Mounting Diagram

8.2.2 MSU, Honeywell, TECSTAR Outlines

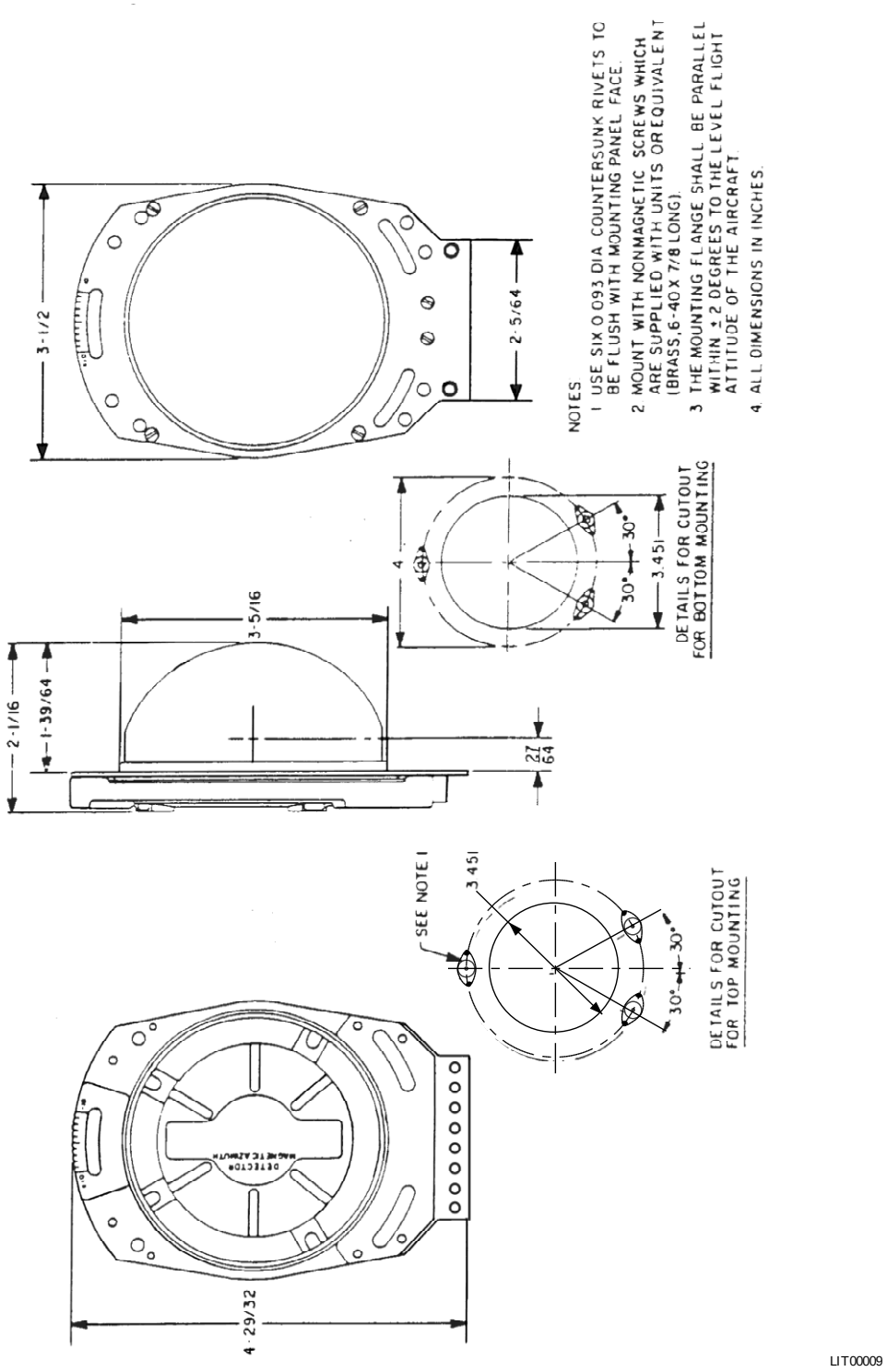


Figure 1-11 FX-120/FX-600/FV-1 MSU Outline and Mounting Diagram

8.2.3 MSU, Honeywell Outlines

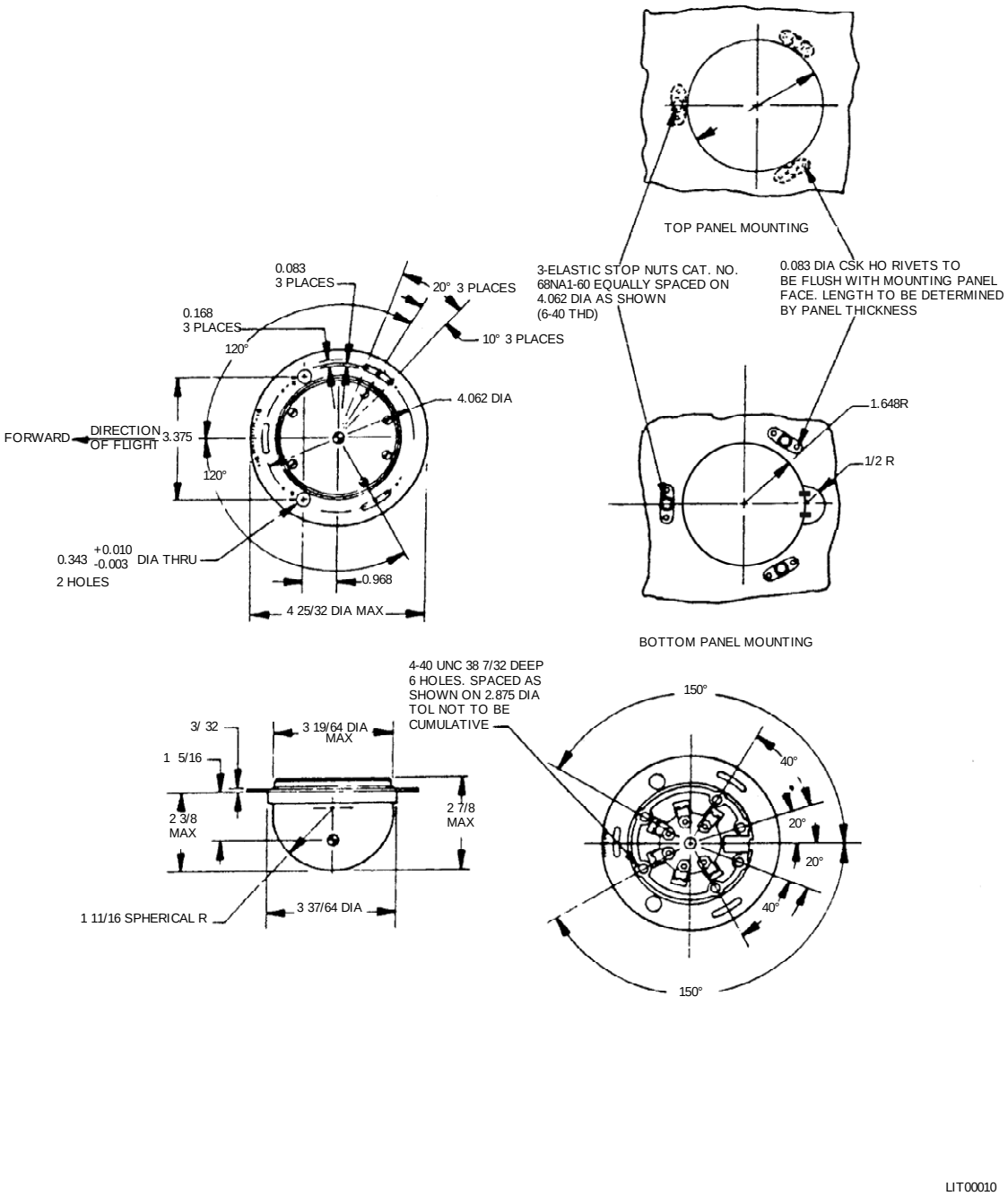


Figure 1-12 FX-125/220 MSU Outline and Mounting Diagram

8.3 Compass Control Unit (CCU) Outlines

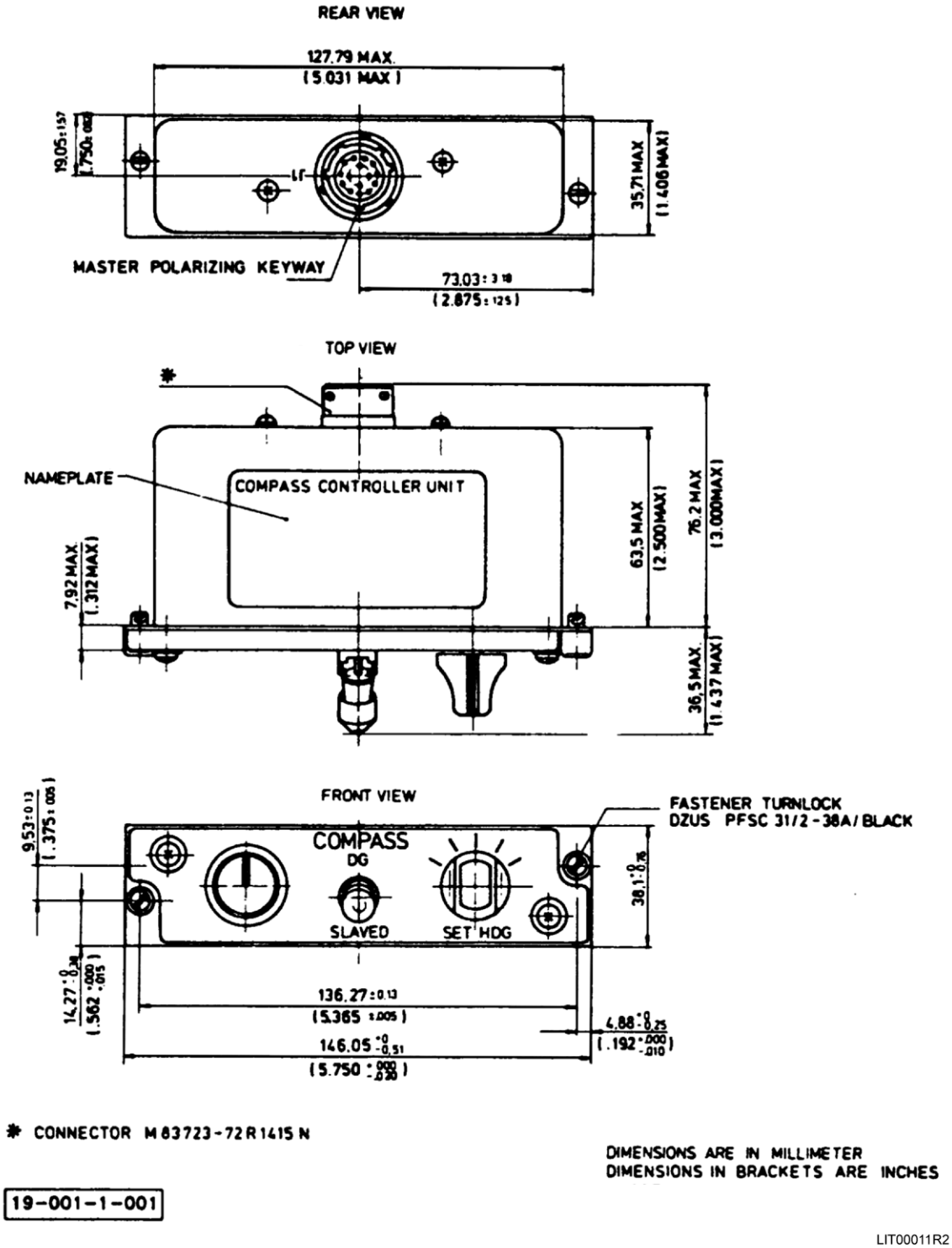


Figure 1-13 CCU Outline and Mounting Diagram

8.4 Mounting Trays

8.4.1 Mounting Tray, ruggedized, without Fan (LCR-100 type)

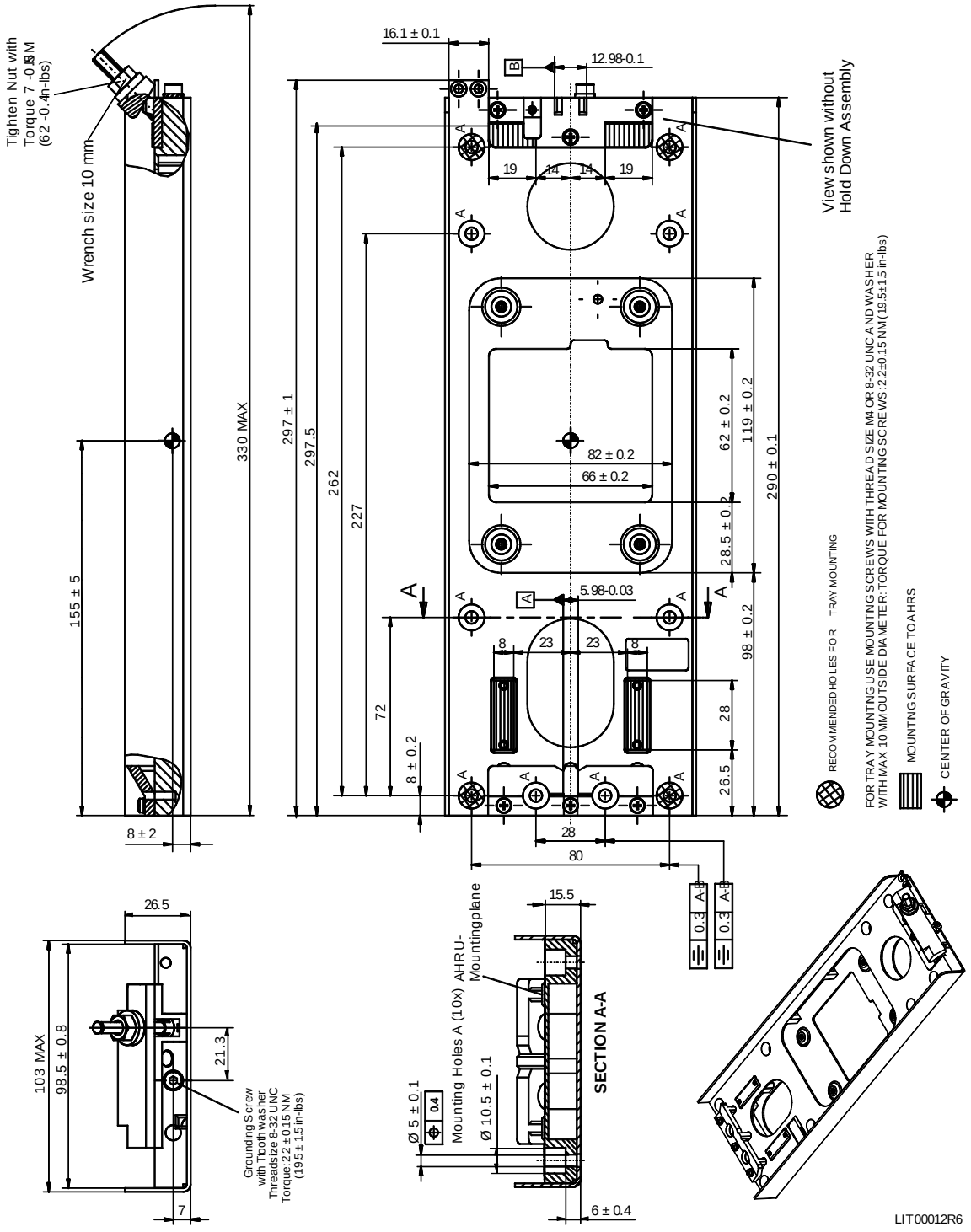


Figure 1-14 Mounting Tray P/N 145137-0100 Outline – without Fan

8.4.2 Mounting Tray, ruggedized, with Fan (LCR-100 type)

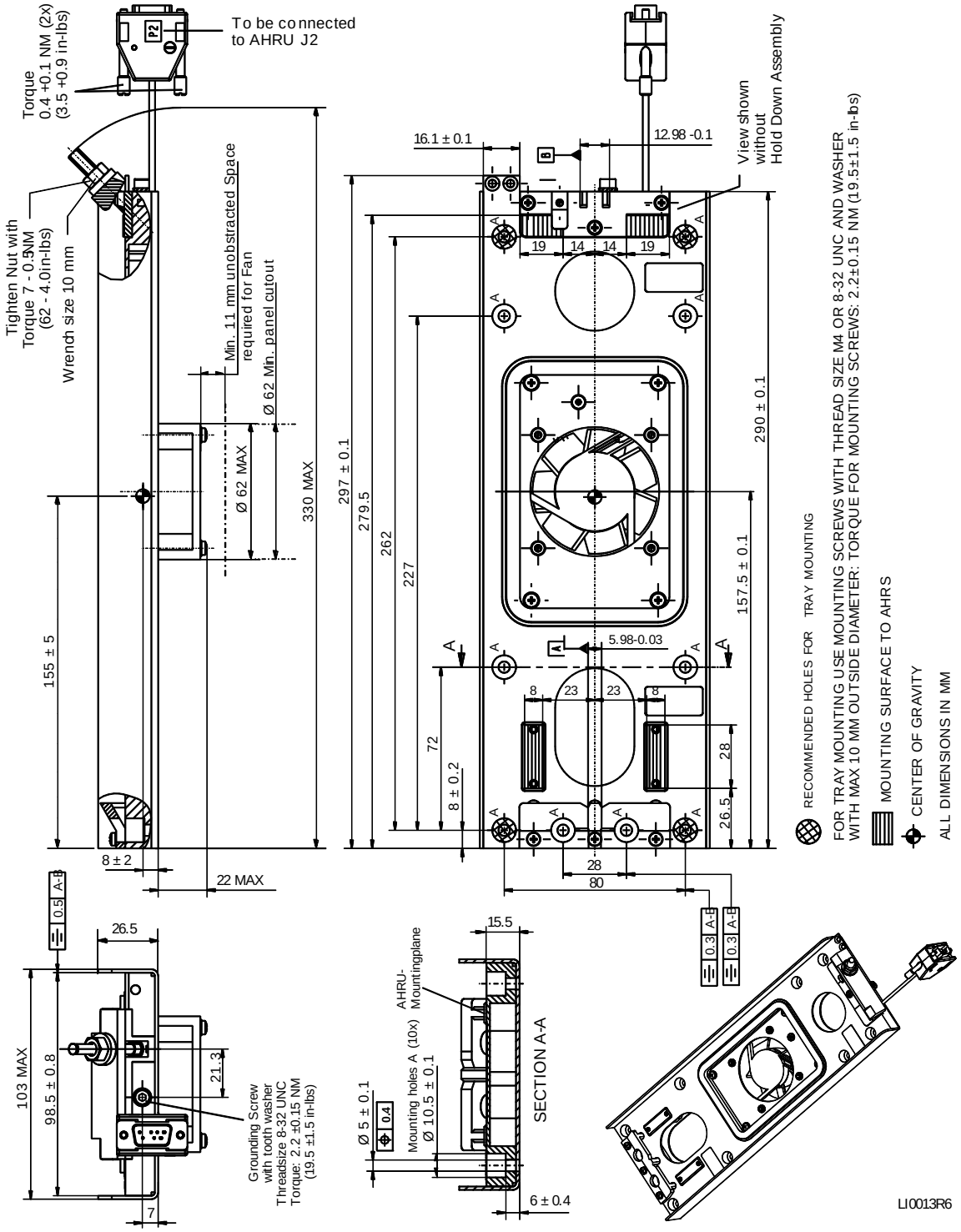

To be connected to AHRU J2
Torque 0.4 +0.1 NM (2x) (3.5 +0.9 in-lbs)
Tighten Nut with Torque 7 - 0.5 NM (62 - 4.0 in-lbs)
Wrench size 10 mm
Min. 11 mm unobstracted Space required for Fan
Ø 62 Min. panel cutout
Ø 62 MAX
330 MAX
155 ± 5
8 ± 2
22 MAX
16.1 ± 0.1
12.98 -0.1
View shown without Hold Down Assembly
297 ± 0.1
279.5
262
227
72
8 ± 0.2
290 ± 0.1
157.5 ± 0.1
5.98-0.03
28
26.5
80
RECOMMENDED HOLES FOR TRAY MOUNTING
FOR TRAY MOUNTING USE MOUNTING SCREWS WITH THREAD SIZE M4 OR 8-32 UNC AND WASHER WITH MAX 10 MM OUTSIDE DIAMETER: TORQUE FOR MOUNTING SCREWS: 2.2±0.15 NM (19.5±1.5 in-lbs)
MOUNTING SURFACE TO AHRS
CENTER OF GRAVITY
ALL DIMENSIONS IN MM
26.5
103 MAX
98.5 ± 0.8
21.3
7
Grounding Screw with tooth washer Threadsize 8-32 UNC Torque: 2.2 ±0.15 NM (19.5 ±1.5 in-lbs)
15.5
AHRU-Mountingplane
Mounting holes A (10x) Ø 10.5 ± 0.1
Ø 5 ± 0.1
SECTION A-A
6 ± 0.4
LI0013R6

Figure 1-15 Mounting Tray P/N 145138-0100 Outline – with Fan

8.4.3 Mounting Tray, standard, without Fan (LCR-92/93 type)

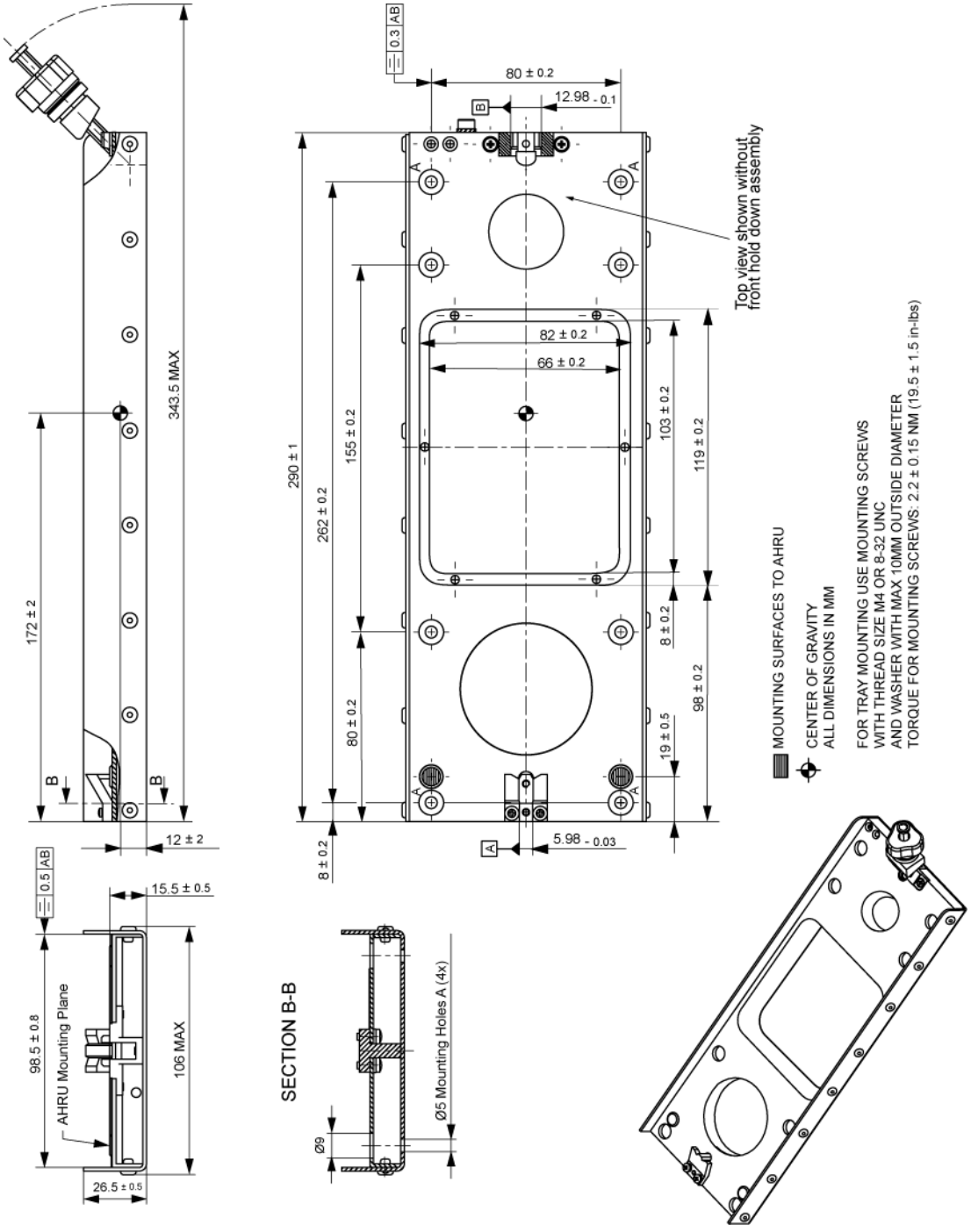


Figure 1-16 Mounting Tray P/N 124260-0000 Outline – without Fan

8.4.4 Mounting Tray, standard, with Fan (LCR-92/93 type)

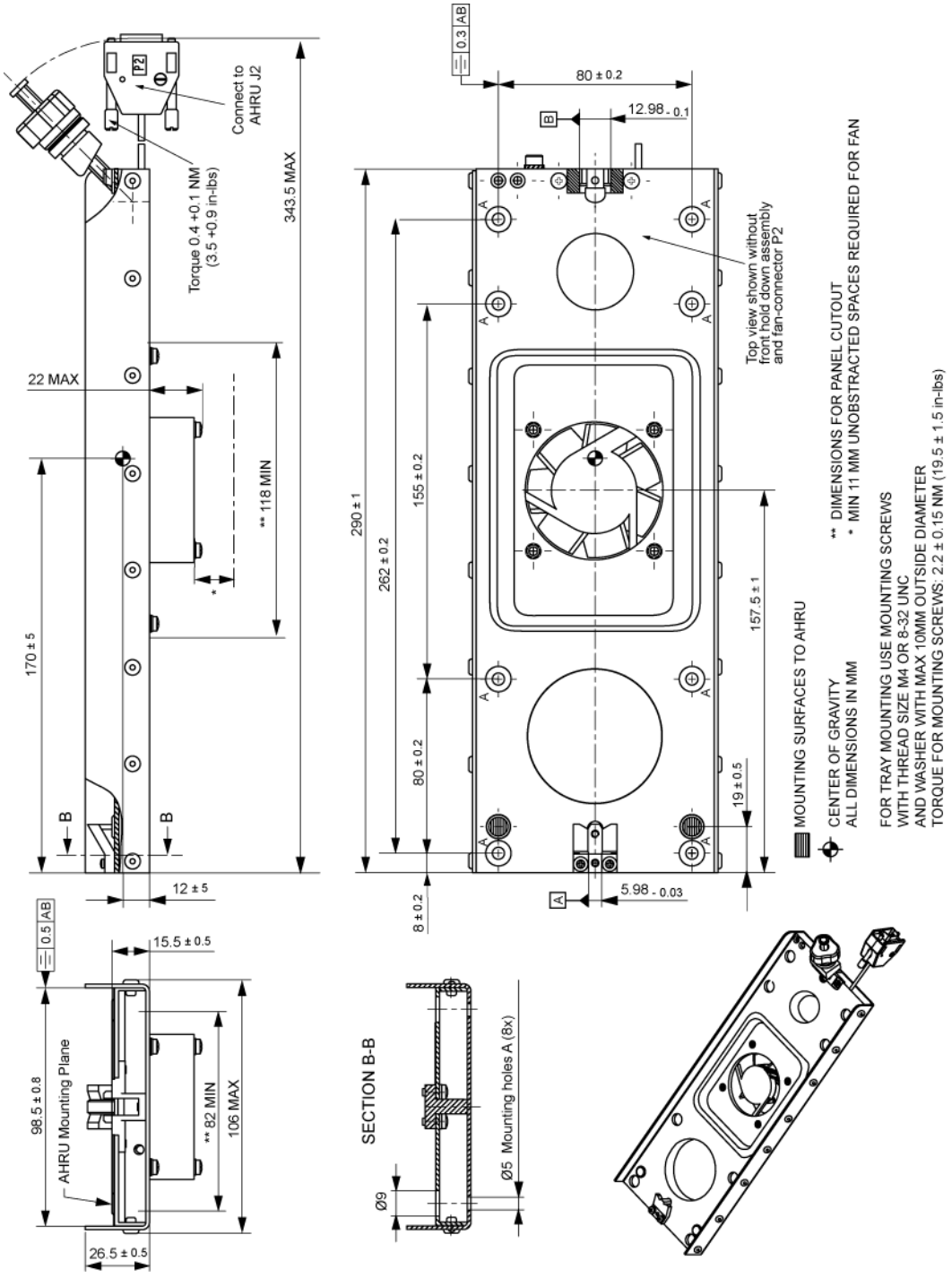

Connect to AHRU J2
Torque 0.4 +0.1 NM (3.5 +0.9 in-lbs)
343.5 MAX
22 MAX
** 118 MIN
170 ± 5
12 ± 5
0.3 AB
80 ± 0.2
12.98 - 0.1
Top view shown without front hold down assembly and fan-connector P2
290 ± 1
262 ± 0.2
155 ± 0.2
80 ± 0.2
157.5 ± 1
19 ± 0.5
8 ± 0.2
5.98 - 0.03
MOUNTING SURFACES TO AHRU
CENTER OF GRAVITY
ALL DIMENSIONS IN MM
** DIMENSIONS FOR PANEL CUTOUT
* MIN 11 MM UNOBSTRACTED SPACES REQUIRED FOR FAN
FOR TRAY MOUNTING USE MOUNTING SCREWS
WITH THREAD SIZE M4 OR 8-32 UNC
AND WASHER WITH MAX 10MM OUTSIDE DIAMETER
TORQUE FOR MOUNTING SCREWS: 2.2 ± 0.15 NM (19.5 ± 1.5 in-lbs)
0.5 AB
15.5 ± 0.5
98.5 ± 0.8
AHRU Mounting Plane
** 82 MIN
106 MAX
26.5 ± 0.5
SECTION B-B
Ø5 Mounting holes A (8x)
Ø9

Figure 1-17 Mounting Tray P/N 140691-0000 Outline – with Fan

8.4.5 Mounting Tray, ruggedized, without Fan (LCR-92/93 type)

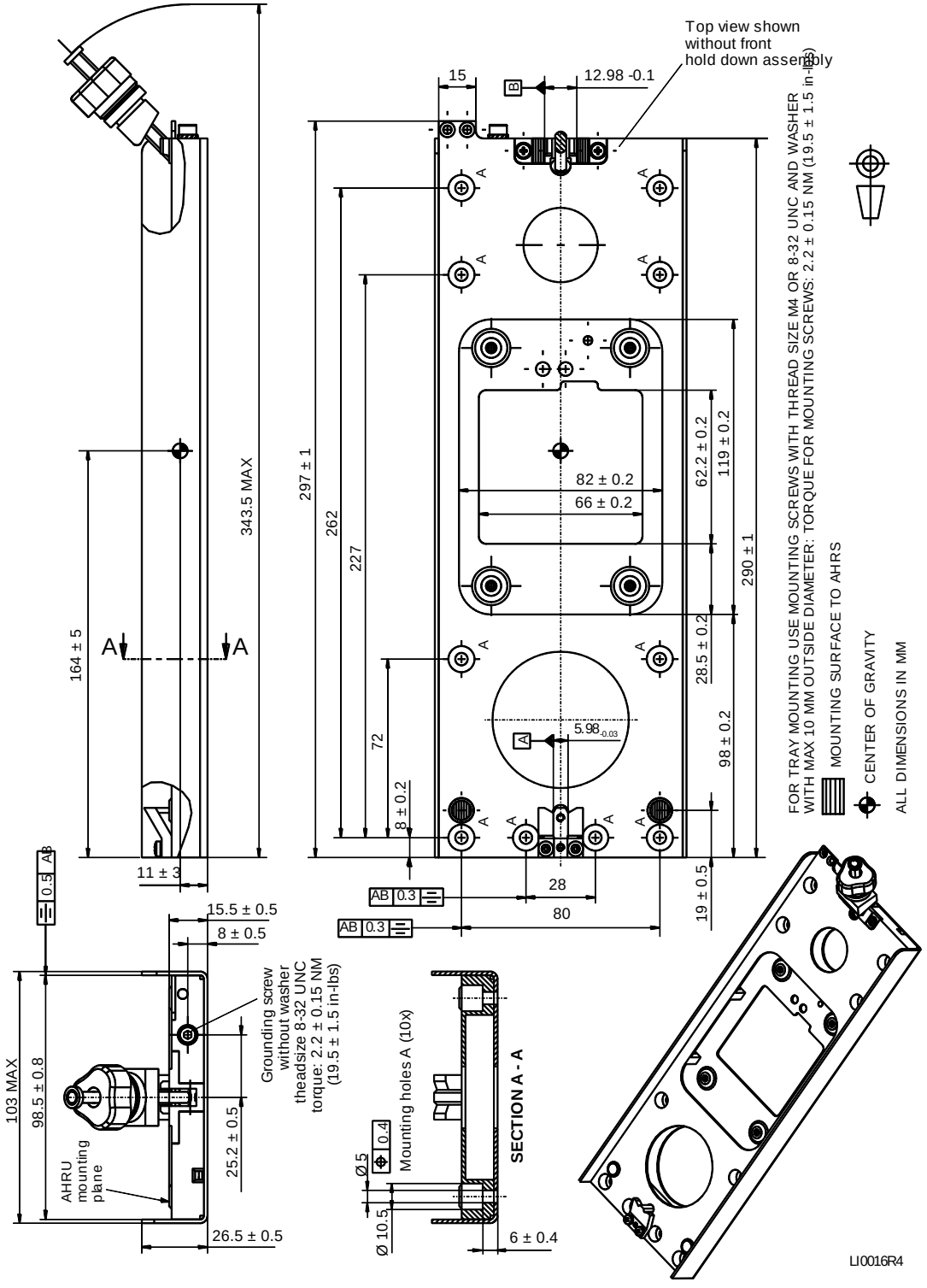


Figure 1-18 Mounting Tray P/N 144201-0000 Outline – without Fan

8.4.6 Mounting Tray, ruggedized, with Fan (LCR-92/93 type)

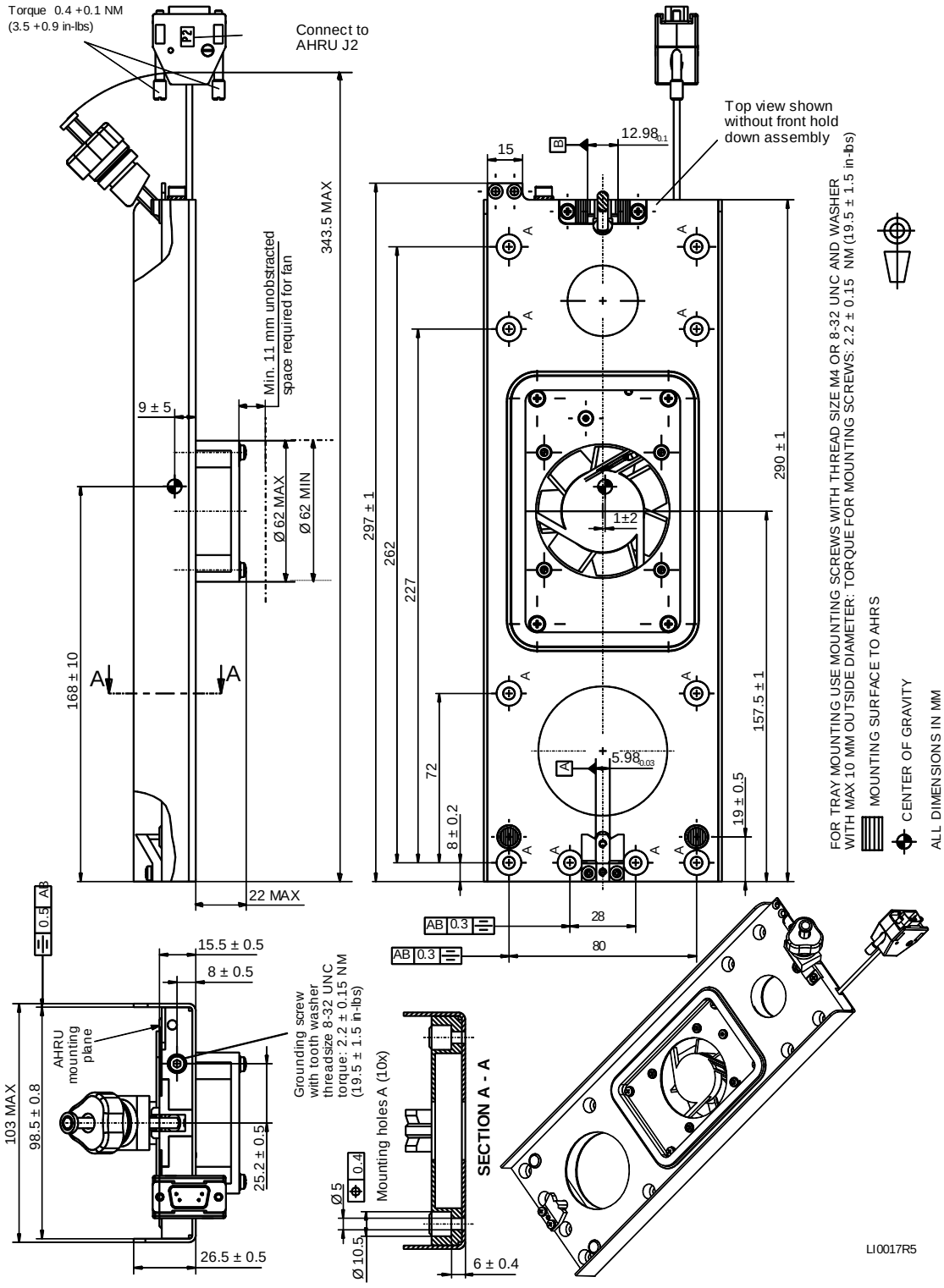


Figure 1-19 Mounting Tray P/N 144200-0000 Outline – with Fan

8.4.7 Installation Data Module (IDM)

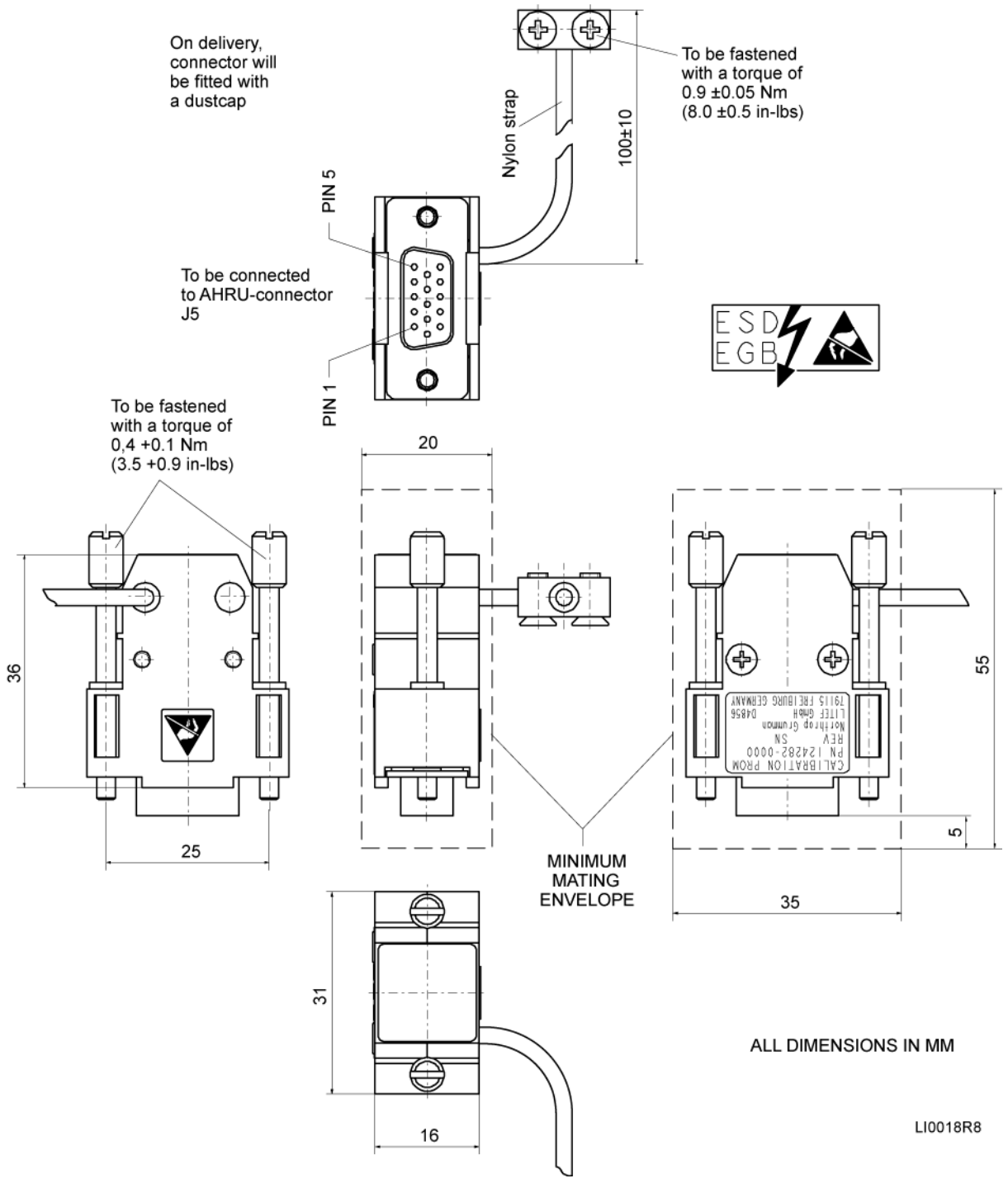


Figure 1-20 IDM P/N 124282-xxxx Outline

9 System Wiring

9.1 Signals and Pin Assignment J1 (Power Supply)

Signal	Pin	In/Out	AWG	Signal Format	Load	Use
+ 28 VDC PRIM A/C POWER	01	I	22	Aircraft 28 VDC	2 A max.	A/C
+ 28 VDC PRIM A/C POWER	09	I	22	Aircraft 28 VDC	2 A max.	A/C
28 VDC PRIM RETURN	02	I	22	Aircraft DC Power Ground	2 A max.	A/C
28 VDC PRIM RETURN	10	I	22	Aircraft DC Power Ground	2 A max.	A/C
+ 28 VDC AUX A/C POWER	03	I	22	Aircraft 28 VDC	2 A max.	A/C
+ 28 VDC AUX A/C POWER	11	I	22	Aircraft 28 VDC	2 A max.	A/C
28 VDC AUX RETURN	04	I	22	Aircraft DC Power Ground	2 A max.	A/C
28 VDC AUX RETURN	12	I	22	Aircraft DC Power Ground	2 A max.	A/C
+ 28 VDC CCU/DISCRETES	08	O	24	28 VDC for CCU and SAV Input Discretes	100 mA max.	A/C
28 VDC RETURN CCU	15	O	24	28 VDC Output Power Ground		
+ 28 VDC MAGNETOMETER POWER	06	O	24	28 VDC for Magnetometer	100 mA max.	A/C
28 VDC RETURN MAGNETOMETER	14	O	24	28 VDC Output Power Ground		
AUX POWER ANNUNCIATOR	07	O	24	Ground signal (refer to section 1, paragraph 4.2.2)	110 mA max.	A/C
The following two assignments are valid for all LCR100 versions except 145130-6200						
+ 28 VDC_SGS_REF	05	O	24	28 VDC Reference for SGS Discretes	100 mA max.	A/C
28 VRTN_SAV_REF	13	O	24	GND Signal Reference for SAV Discretes		
The following two assignments are valid for the LCR100 version 145130-6200						
+ 28 VDC_SGS_REF	13	O	24	28 VDC Reference for SGS Discretes	100 mA max.	A/C
28 VRTN_SAV_REF	05	O	24	GND Signal Reference for SAV Discretes		

Table 1-84 Pin Assignment J1 Power Supply

9.2 Signals and Pin Assignment J2 (Fan Supply)

Signal		Pin	In/Out	AWG	Signal Format	Load	Use
+ 24 VDC FAN POWER		03	O	24	+24VDC fan supply	100 mA max.	Tray Fan
24 VDC RETURN		02	O	24	24VDC fan ground		
FAN TEST ENABLE	A	04	I	24	Jumped to Pin 05		Tray Fan
	B	05	I	24	Jumped to Pin 04		
SPARE		01			Not connected Internally		N/A
SPARE		06					
SPARE		07					
SPARE		08					
SPARE		09					

Table 1-85 Pin Assignment J2 Fan Supply

9.3 Signals and Pin Assignment J3 (Synchro)

J3 is only applicable for systems with installed synchro interface module (LCR-100 P/N 145130-2xxx and -7xxx).

Signal		Pin	In/Out	AWG	Signal Format	Load	Use
ATTITUDE REFERENCE	HI	04	I	24 ts	26 Vrms AC 400 Hz sinusoidal	1 mA RMS max.	A/C
	LO	19	I	24 ts	(refer to section 1, paragraph 4.4.1.1)		
PITCH SYNCHRO	X(S1)	11	O	24 ts	3-Wire Synchro output	3 x (120 + j450) Ω max.	A/C
	Z(S2)	26	O	24 ts	11.8 Vrms 400 Hz		
	Y(S3)	40	O	24 ts	(refer to section 1, paragraph 4.4.2.1)		
ROLL SYNCHRO	X(S1)	10	O	24 ts	3-Wire Synchro output	3 x (120 + j450) Ω max.	A/C
	Z(S2)	25	O	24 ts	11.8 Vrms 400 Hz		
	Y(S3)	39	O	24 ts	(refer to section 1, paragraph 4.4.2.1)		
HEADING 1 REFERENCE	HI	05	I	24 ts	26 Vrms AC 400 Hz sinusoidal (refer to section 1, paragraph 4.4.1.1) Serves heading synchro output no. 1	1 mA RMS max.	A/C
	LO	20	I	24 ts			
HEADING 2 REFERENCE	HI	33	I	24 ts	26 Vrms AC 400 Hz sinusoidal (refer to section 1, paragraph 4.4.1.1) Serves heading synchro output no. 2	1 mA RMS max.	A/C
	LO	34	I	24 ts			
HEADING SYNCHRO No. 1	X(S1)	13	O	24 ts	3-Wire Synchro output 11.8 Vrms 400 Hz (refer to section 1, paragraph 4.4.2.1)	3 x (120 + j450) Ω max.	A/C
	Z(S2)	28	O	24 ts			
	Y(S3)	42	O	24 ts			
HEADING SYNCHRO No. 2	X(S1)	12	O	24 ts	3-Wire Synchro output 11.8 Vrms 400 Hz (refer to section 1, paragraph 4.4.2.1)	3 x (120 + j450) Ω max.	A/C
	Z(S2)	27	O	24 ts			
	Y(S3)	41	O	24 ts			
PITCH AC 200 (167) mV/deg	HI	09	O	24 ts	200 (167) mV/deg Vrms 400 Hz (refer to section 1, paragraph 4.4.2.2)	5 kΩ max.	A/C
	LO	24	O	24 ts			
ROLL AC 200 (167) mV/deg	HI	07	O	24 ts	200 (167) mV/deg Vrms 400 Hz (refer to section 1, paragraph 4.4.2.2)	5 kΩ max.	A/C
	LO	22	O	24 ts			
PITCH AC 50 mV/deg	HI	08	O	24 ts	5 mV/deg Vrms 400 Hz (refer to section 1, paragraph 4.4.2.2)	10 kΩ max	A/C
	LO	23	O	24 ts			
ROLL AC 50 mV/deg	HI	06	O	24 ts	50 mV/deg Vrms 400 Hz (refer to section 1, paragraph 4.4.2.2)	10 kΩ max	A/C
	LO	21	O	24 ts			
ATTITUDE WARN DISCRETE	A	03	O	24	Relay Contact (refer to section 1, paragraph 4.2.2)	110 mA max.	A/C
	B	18	O	24			
HEADING WARN DISCRETE 1	A	32	O	24	Relay Contact (refer to section 1, paragraph 4.2.2)	110 mA max.	A/C
	B	17	O	24			
HEADING WARN DISCRETE 2	A	16	O	24	Relay Contact (refer to section 1, paragraph 4.2.2)	110 mA max.	A/C
	B	01	O	24			

Signal		Pin	In/Out	AWG	Signal Format	Load	Use
TURN RATE WARN DISCRETE	A	02	O	24	Relay Contact (refer to section 1, paragraph 4.2.2)	110 mA max.	A/C
	B	31	O	24			
TURN RATE DC	HI	15	O	24 ts	2-Wire DC ± 4 V (refer to section 1, paragraph 4.4.2.3.3)	1 kΩ max.	A/C
	LO	30	O	24 ts			
TURN RATE DC RETURN		43	O	24	Ground reference for turn rate 500Ω impedance		
YAW RATE DC	HI	14	O	24 ts	2-Wire DC ± 4 V (refer to section 1, paragraph 4.4.2.3.2)	1 kΩ max.	A/C
	LO	29	O	24 ts			
YAW RATE DC RETURN		44	O	24	Ground reference for yaw rate 500Ω impedance		
NORMAL ACCELERATION DC	HI	37	O	24 ts	2-WIRE DC ± 3.83 V (refer to section 1, paragraph 4.4.2.3.4)	1 kΩ max.	A/C
	LO	38	O	24 ts			
NORMAL ACC TEST ENABLE		36	I	24	Signal	1 mA max.	A/C
NORMAL ACC TEST REF		35	I	24	Reference for J3-36		

Table 1-86 Pin Assignment J3 Synchro Interface Module

ts = twisted and shielded

9.4 Signals and Pin Assignment J4 (Input/Output)

Signal		Pin	In/Out	AWG	Signal Format	Load	Use
MSU Interface							
MSU EXCITATION	HI	02	O	24 ts	12-23 VRMS, 400 Hz (refer to section 1, paragraph 4.5)	MSU	A/C
	LO	22	O	24 ts			
MSU SIGNAL INPUT	A	09	I	24 ts	800 Hz (refer to section 1, paragraph 4.5)	2 mA RMS max.	A/C
	B	51	I	24 ts			
	C	30	I	24 ts			
MSU REFERENCE OUT		39	O	24	Refer to section 1, paragraph 9.7		A/C
MSU REFERENCE IN		60	I	24			
SLAVING ERROR	HI	10	O	24 ts	Analog DC, (refer to section 1, paragraph 4.4.2.3.1)	1 kΩ max.	A/C
	LO	31	O	24 ts			
MAGRTN		50	O	24	Ground reference for MSU 500Ω impedance		A/C
Discretes							
PROG. PIN COMMON		32	O	24	28 VRTN_SAV_REF Signal for program pins (ref. to sect. 1, para. 4.2.1.2)		A/C
MOUNTING POSITION	No. 1	14	I	24	SGS (refer to section 1, paragraph 4.2.1.2)	3 mA max.	A/C
	No. 2	35	I	24			
SOURCE DESTINATION IDENTIFIER	No. 1	34	I	24			
	No. 2	54	I	24			
DG MODE LOGIC SELECT		12	I	24			
GROUND/AIR LOGIC SELECT		01	I	24			
PARITY		43	I	24			
ARINC TURN RATE SELECT		17	I	24	SAV (ref. to sect. 1, para. 4.2.1.2)	3 mA max.	A/C
YR SCALE / DADS SELECT	No. 1	53	I	24	SGS (ref.to sect.1, para. 4.2.1.2 / 4.2.1.3)	3 mA max.	A/C
	No. 2	11	I	24			
MSU EXCITATION VOLTAGE SELECT		23	I	24	SGS (refer to section 1, paragraph 4.2.1.2)	3 mA max.	A/C
MSU CALIBRATION DISCRETE		38	I	24	SAV (refer to section 1, paragraph 4.2.1.3)	3 mA max.	A/C
SELFTEST DATA ENABLE		55	I	24	SGS (refer to section 1, paragraph 4.2.1.3)	3 mA max.	A/C
DG/MAG MODE SELECT		57	I	24	SAV (refer to section 1, paragraph 4.2.1.3)	3 mA max.	A/C
ATT MODE SELECT		04	I	24	SGS (refer to section 1, paragraph 4.2.1.3)	3 mA max.	A/C
GYROCOMPASS MODE SELECT		56	I	24			
SLEW LEFT		16	I	24	SAV (refer to section 1, paragraph 4.2.1.3)	3 mA max.	A/C
SLEW RIGHT		58	I	24			
ON GND / IN AIR DISCRETE		37	I	24	SGS (refer to section 1, paragraph 4.2.1.3)	3 mA max.	A/C
STORED HDG ALIGNMENT		52	I	24			
SYNCHRO TRUE/MAG HDG SELECT		25	I	24			
ARINC UPDATE RATE SELECT		44	I	24	(refer to section 1, paragraph 4.2.1.2)		

Signal		Pin	In/Out	AWG	Signal Format	Load	Use
SPARE DISCRETE		24	I	24	SAV (Spare, no function - do not connect)		N/A
ATT MODE ANNUNCIATOR	A	62	O	24	Relay Contact (refer to section 1, paragraph 4.2.2)	110 mA max.	A/C
	B	20	O	24			
AUTOPILOT HEADING INTERLOCK	A	19	O	24	Relay Contact (refer to section 1, paragraph 4.2.2)	110 mA max.	A/C
	B	40	O	24			
SYSTEM WARN	A	21	O	24	Relay Contact N.O.	110 mA max.	A/C
	C	15	O	24	Relay Contact N.C.		
	B	42	O	24	(refer to section 1, paragraph 4.2.2)		
YAW RATE WARN / BASIC MODE ANNUNCIATOR	A	41	O	24	Relay Contact	110 mA max.	A/C
	B	61	O	24	(refer to section 1, paragraph 4.2.2)		
Digital Interfaces							
ARINC 429 OUTPUT DATA BUS No.1	A	08	O	24 ts	ARINC-429, HI-Speed		A/C
	B	29	O	24 ts	(refer to section 1, paragraph 4.3.2.1)		
ARINC 429 OUTPUT DATA BUS No.2	A	49	O	24 ts	ARINC-429, HI-Speed		A/C
	B	07	O	24 ts	(refer to section 1, paragraph 4.3.2.1)		
ARINC 429 OUTPUT DATA BUS No.3	A	28	O	24 ts	ARINC-429, HI-Speed		A/C
	B	48	O	24 ts	(refer to section 1, paragraph 4.3.2.1)		
ARINC 429 OUTPUT DATA BUS No.4	A	26	O	24 ts	ARINC-429, HI-Speed		A/C
	B	46	O	24 ts	(refer to section 1, paragraph 4.3.2.1)		
ARINC 429 INPUT DATA BUS No.1	A	06	I	24 ts	ARINC-429, DADS Input; HI/LO-Spd.	20 kΩ diff. max.	A/C
	B	27	I	24 ts	(refer to section 1, paragraph 4.3.1.2)		
ARINC 429 INPUT DATA BUS No.2	A	47	I	24 ts	ARINC-429, DADS Input; HI/LO-Spd.	20 kΩ diff. max.	A/C
	B	05	I	24 ts	(refer to section 1, paragraph 4.3.1.2)		
GND		18	O	24	Secondary Signal Ground		
		59	O	24			
TIME MARK A	HI	45	I	24 ts	GPS Time Mark Input. (refer to section 1, paragraph 4.3.1.5.) Must not be used simultaneously with Time Mark A input on J6 Pin 39/40	100 Ω diff. max.	A/C
	LO	03	I	24 ts			
SPARE		36			Not connected internally		N/A
		33					
		13					

Table 1-87 Pin Assignment J4

ts = twisted and shielded;

9.5 Signals and Pin Assignment J5 (IDM)

Signal		Pin	In/Out	AWG	Signal Format	Load	Use
+ 5 VDC IDM POWER		01	O	24	+ 5 VDC		IDM
5 VDC RETURN		02	O	24	Secondary Signal Ground		
STXD		03	O	24	TTL Signals for the serial EEPROM		IDM
SRXD		04	I	24			
STXCLK		05	O	24			
SPROMCS		06	O	24			
ENGINEERING MODE ENABLE		07	I	24	TTL (Test & Maintenance, do not connect)		Test
COMMAND INTERFACE SELECT		08	I	24			
GPS Backup Battery Input	+	09	I	24	Backup Battery in IDM (Battery not installed) - not connected internally		N/A
GPS Backup Battery Return	-	10	I	24	Secondary Signal Ground		
GND		11	O	24	Ground reference for RS-422, 100Ω impedance (Test & Maintenance, do not connect)		Test
RS-422 RXD	HI	12	I	24 ts	RS-422 (Test & Maintenance, do not connect)	100 Ω diff. max.	Test
	LO	13	I	24 ts			
RS-422 TXD	HI	14	O	24 ts	RS-422 (Test & Maintenance, do not connect)		Test
	LO	15	O	24 ts			

Table 1-88 Pin Assignment J5

ts = twisted and shielded

9.6 Signals and Pin Assignment J6 (Input/Output and Test)

Signal		Pin	In/Out	AWG	Signal Format	Load	Use
ARINC 429 OUTPUT DATA BUS No.5	A	01	O	24 ts	ARINC-429, HI-Speed		A/C
	B	02	O	24 ts	(refer to section 1, paragraph 4.3.2.1)		
ARINC 429 OUTPUT DATA BUS No.6	A	03	O	24 ts	ARINC-429, HI-Speed		A/C
	B	04	O	24 ts	(refer to section 1, paragraph 4.3.2.1)		
GND		05	O	24	Secondary Signal Ground		A/C
ARINC 429 INPUT DATA BUS No.3	A	06	I	24 ts	ARINC-429, GNSS Input A, HI/LO-Spd.	20 kΩ diff. max.	A/C
	B	07	I	24 ts	(refer to section 1, paragraph 4.3.1.3)		
ARINC 429 INPUT DATA BUS No.4	A	08	I	24 ts	ARINC-429, GNSS Input B, HI/LO-Spd.	20 kΩ diff. max.	A/C
	B	09	I	24 ts	(refer to section 1, paragraph 4.3.1.3)		
ARINC 429 INPUT DATA BUS No.5	A	10	I	24 ts	ARINC-429, CDU/FMS Input, HI/LO-Speed (refer to section 1, paragraph 4.3.1.4)	20 kΩ diff. max.	A/C
	B	11	I	24 ts			
ARINC 429 INPUT DATA BUS No.6	A	12	I	24 ts			
	B	13	I	24 ts			
GND		14	O	24	Secondary Signal Ground		A/C
RS-232 IN_1		15	I	24 s	Debug Interface (Test & Maintenance, do not connect to A/C wiring) (ref. to sect. 1, para. 4.6.2)		L1MS
RS-232 OUT_1		16	O	24 s			

Signal		Pin	In/Out	AWG	Signal Format	Load	Use
GND		17	O	24	Secondary Signal Ground		A/C
TEST MODE DISCRETE		18	I	24	Referenced to Secondary Sig. Ground (Test & Maintenance, do not connect to A/C wiring) (refer to section 1, paragraph 4.2.1.3)	1 mA max.	L1MS
SPARE		19			Not connected internally		N/A
		20					
		21					
		22					
		23					
		24					
		25					
		26					
		27					
		28					
RS422 TXD1	HI	29	O	24 ts	Data Magnetometer (Spare, no function - do not connect)		N/A
	LO	30	O	24 ts			
MAGNETOMETER RETURN		31	O	24	Reference for Magnetometer 250Ω impedance (Spare, no function - do not connect)		N/A
RS422 RXD1	HI	32	I	24 ts	Data Magnetometer (Spare, no function - do not connect)	100 Ω diff. max.	N/A
	LO	33	I	24 ts			
Ethernet TX	HI	34	O	24 ts	Ethernet (Test & Maintenance, do not connect to A/C wiring) (refer to section 1, paragraph 4.6.3)		Test
	LO	35	O	24 ts			
Ethernet RX	HI	36	I	24 ts		100 Ω diff. max.	Test
	LO	37	I	24 ts			
GND		38	O	24 s	Secondary Signal Ground		A/C
Time Mark A	HI	39	I	24 ts	GPS Time Mark Input (refer to section 1, paragraph 4.3.1.5) Must not be used simultaneously with Time Mark A input on J4 Pin 45/03	100 Ω diff. max.	A/C
	LO	40	I	24 ts			
Time Mark B	HI	41	I	24 ts	GPS Time Mark Input (refer to section 1, paragraph 4.3.1.5)	100 Ω diff. max.	A/C
	LO	42	I	24 ts			
SPARE		43			Not connected internally		N/A
		44					

Table 1-89 Pin Assignment J6

ts = twisted and shielded
s = shielded

9.7 Interconnection MSU/LCR-100

AHRU Input / Connector/Pin	Honeywell FX-Series, TECSTAR	Bendix/King KMT 112
J4-09	A	D
J4-51	B	A
J4-30	C	B
J4-02	D	H
J4-22	E	E
Not connected	F	
J4-39 and J4-60 connected together (mandatory)		

Table 1-90 AHRU/MSU Wiring

The shielded multiple conductor cable carrying the sensitive signals from the MSU should have its shield grounded at the strain relief of the J4 connector backshell.

MSU interconnection cables often have a break and use adapter plugs. At these adapter plugs the cable shields need to be grounded at the strain relief of the connector backshells as well.

9.8 Interconnection CCU/LCR-100

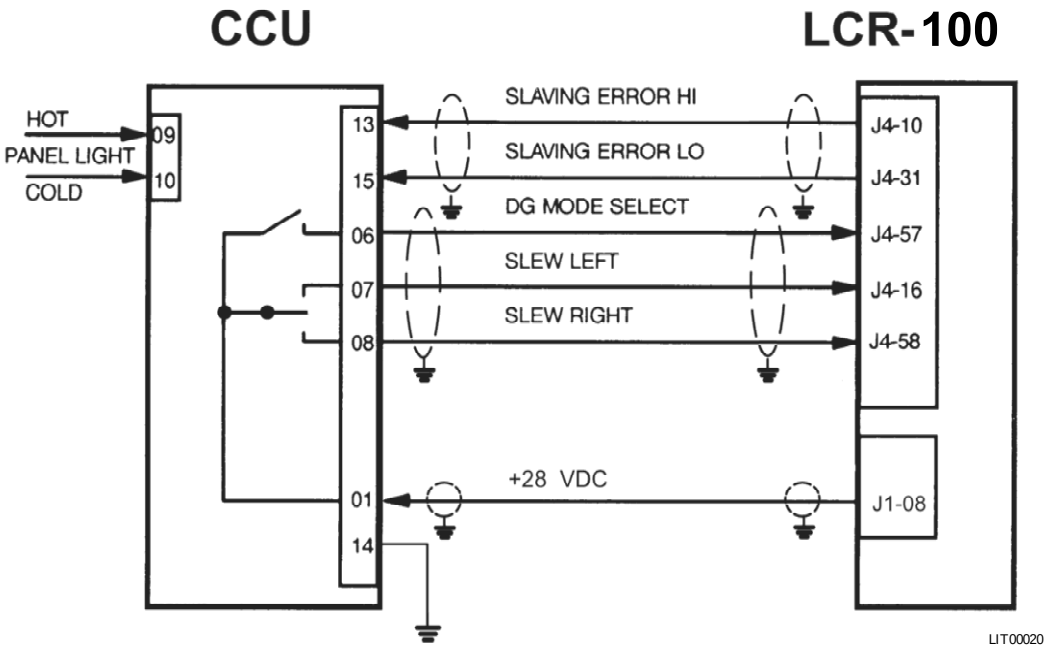


Figure 1-21 Interconnection Diagram CCU, LCR-100

PANEL LIGHT VOLTAGE (supplied by aircraft)	CCU P/N 140855-0010 CCU P/N 140855-0030	CCU P/N 140855-0020 CCU P/N 140855-0040
CCU 1 - 09	+ 5 V (hot)	+ 28 VDC
CCU 1 - 10	PNLLITE (cold)	28 VRTN

Table 1-91 Interconnection CCU Panel Light Voltage

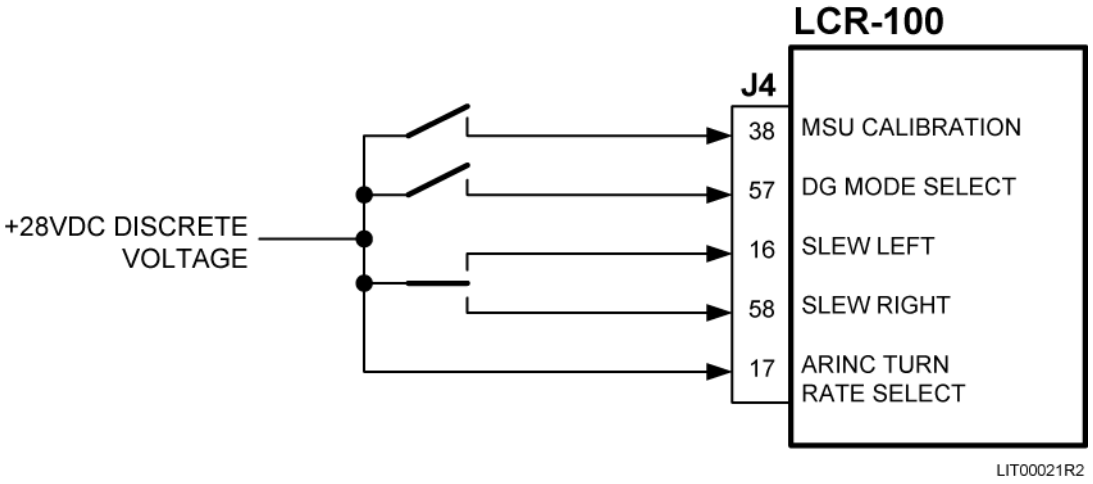


Figure 1-22 Interconnection Diagram for SAV Control Discretes

9.9 Program Pins

For usage of external program control pins refer to section 1, paragraph 3.

For internal program control pins use jumpers to program pin common (J4-32) which is SGS reference (refer to section 1, paragraph 4.2.1.2).

For ARINC Turn Rate Select a SAV reference is required which should be connected as shown in Figure 1-22.

9.10 Wiring Cross Sections

9.10.1 Cross Section of Power Lines

The required cross section of the power lines depends on the length of the power cable. Due to the inrush current described in section 1 paragraph 1.5. The voltage drop across the input power cable has to be limited. The cross section of the input power cable shall be designed for a maximum series resistance of 800 mOhms (for power source series impedance, +28VDC A/C Power input line and 28VDC_RTN line in sum).

9.10.2 Cross Section of Interface Lines

The maximum load currents are limited to 110 mA (refer to column "Load" of tables Table 1-84 to Table 1-89). Therefore the cross section for the interface wires can vary between AWG 24 which is recommended by NG LITEF but can be reduced to AWG 28 without any restrictions or impact on the HIRF protection of the LCR-100.

9.10.3 Recommendations due to HIRF Aspects

The LCR-100 is designed for high level HIRF requirements. To fulfill these requirements the external wiring and shielding terminations from the LCR-100 to other A/C equipment has to fit into this concept. In this paragraph NG LITEF gives advices for an overall HIRF system protection in conjunction with the LCR-100 AHRU.

Twisted and Shielded Wires

Wires should be shielded or twisted and shielded as defined in paragraphs 9.1 through 9.6 with an insulating jacket over the shield: The shield should be carried through each break and should be connected at both ends externally to the equipment using metal backshell / strain relief of the respective connector (refer to Figure 1-23). An overbraid or the Pigtail method shall be avoided.

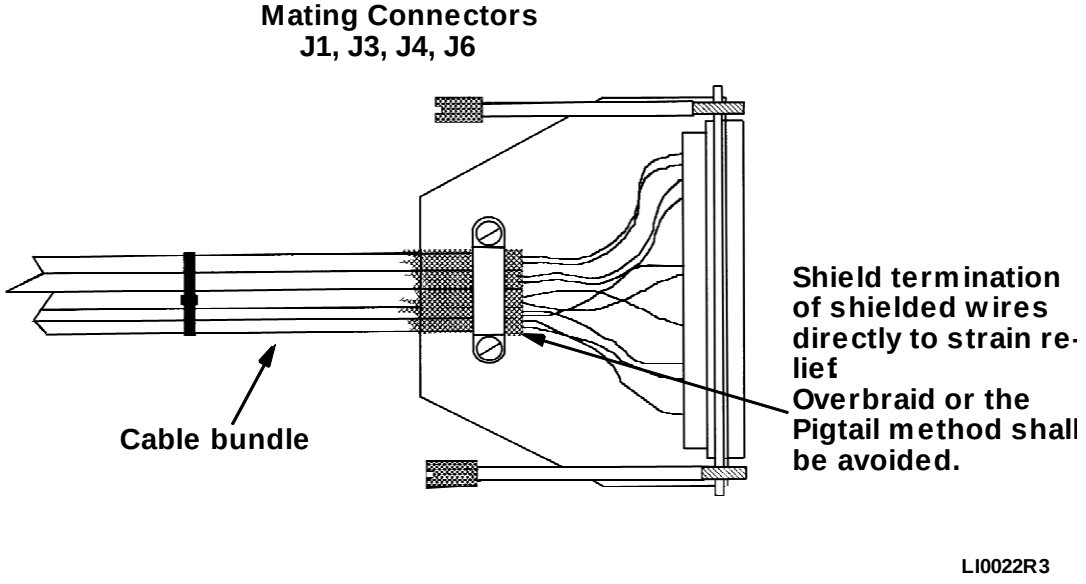

Mating Connectors
J1, J3, J4, J6
Shield termination of shielded wires directly to strain relief
Overbraid or the Pigtail method shall be avoided.
Cable bundle
LI0022R3

Figure 1-23 Shield Termination of Connectors using Metal Backshell / Strain Relief Method

Backshell

The mating connectors with metric (M3) screw locks should have a full metallic backshell. Metallized plastic backshells should be avoided due to quality limitations of the metallization over system life time.

Program Pin Jumper

The jumpers used to connect the program pins to the program pin commen (J4-32) should be as short as possible. A short wrap around within the metallic backshell protects these signals and is therefore recommended.

MSU Reference Jumper

The jumper used to connect the MSU reference output (J4-39) to the MSU reference input (J4-60) should be as short as possible. A short wrap around within the metallic backshell is recommended.

Overall Shielding

Control discretes, warning discretes, secondary signal ground and A/C power inputs are un-shielded wires within the cable bundles. If a further safety margin to the specified HIRF level is desired an overall shield on these wires is recommended for the individual cable bundles. The shield has to be grounded on both sides in the same manner as shown in Figure 1-23 for the individual twisted pair shields.

Unused AHRU connectors

LCR-100 AHRU connectors which are unused during operation shall be covered by a metal backshell (only use backshells with M3 screw locks) to seal the LCR-100 housing against HIRF (e.g. CONEC: D-SUB shielded cap).

NOTE

The use of ESD protective caps or metallized plastic caps is not sufficient.

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SECTION 2

DESCRIPTION AND OPERATION

1 General

This section provides on-aircraft maintenance procedures for the LCR-100 Attitude and Heading Reference System (AHRS). A system consists of an Attitude and Heading Reference Unit (AHRU), an Installation Data Module (IDM), a Magnetic Sensor Unit (MSU) (optional for P/N 145130-1xxx, -2xxx and -3000) and optionally a compass controller unit (CCU).

Section 1, Installation Instructions, contains information that can be pertinent to on-aircraft maintenance of the AHRS; that information should be used in conjunction with this section when applicable.

2 Purpose of Equipment

The LCR-100 is an all attitude inertial sensor system which provides aircraft attitude, heading and flight dynamics (body rates and accelerations) information, which are typically used for flight control and pilot displays.

3 Leading Particulars

Leading particulars for the AHRS are provided in section 1, paragraph 1, Installation Data.

4 Description

Descriptive information pertaining to the AHRS units is provided in the following paragraphs:

4.1 Location of Units in Aircraft

Provided in section 1, paragraph 1.4, Location.

4.2 Outline and Mounting Drawings

Outline and mounting drawings for the AHRU, MSU, CCU, AHRU trays and IDM are provided in section 1, paragraph 8.

4.3 AHRU

The system is mechanized as a strap down inertial measurement system using fiber optic rate sensors and micro-mechanic accelerometers which are "strapped down" to the principle aircraft axes. A digital computer mathematically integrates the rate and acceleration data to obtain heading, pitch and roll attitude. Augmented by air data the system also provides filtered inertial altitude and vertical velocity.

The LCR-100 Gyrocompass versions are equipped with inertial grade instruments which enable a gyrocompassing heading alignment. After a gyrocompassing the system operates in navigation mode like an Inertial Reference System (IRS) in which it provides free inertial navigation position and velocity outputs additionally to the basic AHRS functions.

4.4 IDM

Figure 2-1 Installation Data Module (IDM)

The IDM is an external detachable device that provides the capability to store installation data. The compensation values stored in the IDM are aircraft specific. The IDM is mechanically connected with the Tray and connected to the AHRU via connector J5. As long as the Tray is mounted to the A/C the installation data are valid for any LCR-100 AHRU that is mounted into this Tray without the need to determine installation-, calibration- or compensation-data again.

The IDM provides the capability to store the following installation data:

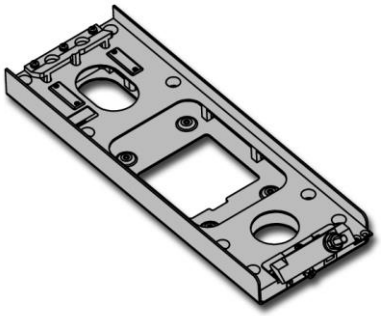
Stored installation data	**P/N 124282-**			
	0000	**2XXX**	**2100**	**2200**
MSU Calibration data (including index error compensation)	X	X	X	X
GNSS antenna lever arms for both GNSS input from the AHRU to the antenna (refer to Figure 3-9)	X	X	X	X
Lever arms from the AHRU to the center of gravity (refer to Figure 3-10)	X	X	X	X
GNSS maximum delay time (time mark to latest related GNSS data set)	X	X	X	X
AHRU misalignment compensation data	X	X	X	X
Programming constant for activation of processing the Label 350 on the DADS input	X	X	X	X
MagVar Model Data (WMM Data) Storage capacity	--	X	X	X
MagVar Model Data (WMM 2010 Data)	--	--	X	--
MagVar Model Data (WMM 2015 Data)	--	--	--	X

Table 2-1 Installation data that can be stored in the IDM

CAUTION

The IDM must be installed (connected with AHRU) in any case, even if no data are stored in it!

4.5 Mounting Tray



The LCR-100 is designed to fit in all mounting trays listed in Overview-Table 1-3.

Trays with fan are recommended to achieve additional reliability margin.

Figure 2-2 Mounting Tray without fan (Example)

To achieve the specified inertial navigation performance of LCR-100 Gyrocompass-Systems with P/N 145130-1xxx, -2xxx and -3000 use the trays:

- P/N: 145137-0100 (LCR-100 ruggedized tray without fan)
- P/N: 145138-0100 (LCR-100 ruggedized tray with fan)

Operation in Navigation Mode is only certified for these trays.

LCR-100 System with P/N 145130-1002 and -1005 can also be installed in trays:

- P/N: 144201-0000 (LCR-92/93 ruggedized tray without fan)
- P/N: 144200-0000 (LCR-92/93 ruggedized tray with fan)

if operated in Attitude Mode only. Operation in Navigation Mode is not certified for these trays.

All LCR-100 Standard Systems with P/N 145130-6xxx or -7xxx can also be installed in trays:

- P/N: 124260-0000 (LCR-92/93 standard tray without fan)
- P/N: 140691-0000 (LCR-92/93 standard tray with fan)

For helicopter applications of LCR-100 Standard Systems with P/N 145130-6xxx or -7xxx the following listed ruggedized trays are recommended as minimum:

- P/N: 145137-0100 (LCR-100 ruggedized tray without fan)
- P/N: 145138-0100 (LCR-100 ruggedized tray with fan)
- P/N: 144201-0000 (LCR-92/93 ruggedized tray without fan)
- P/N: 144200-0000 (LCR-92/93 ruggedized tray with fan)

The specified performance under environmental conditions (DO-160E section 8): "High level short duration sinusoidal vibration" and "Helicopter sine on random vibration" is not certified for the trays:

- P/N: 124260-0000 (LCR-92/93 standard tray without fan)
- P/N: 140691-0000 (LCR-92/93 standard tray with fan)

4.6 MSU

MSU's can optional be used in conjunction with Standard AHRS systems LCR-100 with P/N 145130-6xxx and -7xxx.

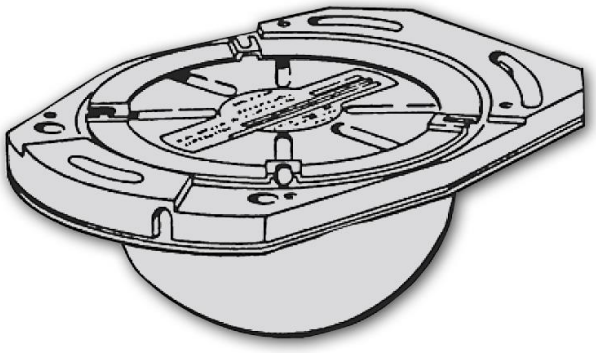


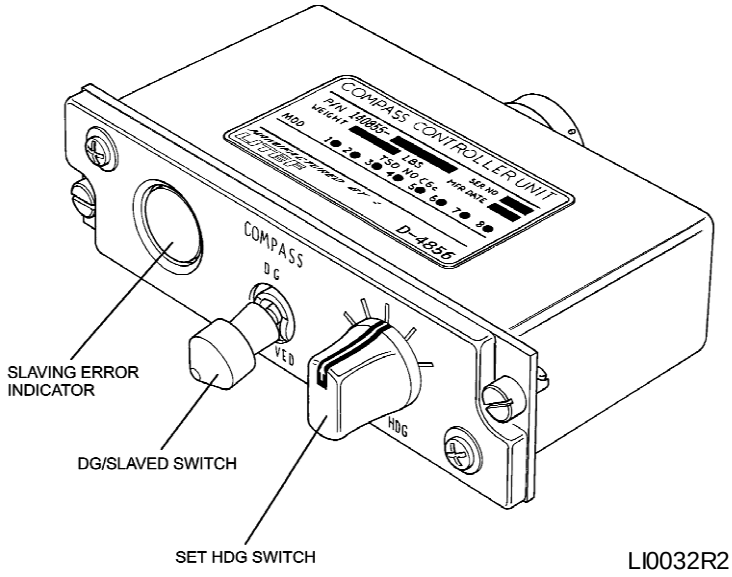
Figure 2-3 Magnetic Sensor Unit (Example)

The magnetic sensor unit detects the horizontal component of the earth's magnetic field and transmits it to the AHRU for use as long term heading reference. In an airplane it can usually be found in the wingtip or in the horizontal or vertical tail section. In helicopters MSUs are usually located in the tail boom assembly. These areas are selected to minimize interference by ferromagnetic materials and magnetic fields generated by the aircraft.

4.7 Control

4.7.1 CCU

A CCU can optional be used in conjunction with Standard AHRS systems LCR-100 with P/N 145130-6xxx and -7xxx.



The CCU contains controls and annunciators to facilitate manual slaving of the AHRU to the MSU and provides the following additional capabilities to the AHRS:

- Setting of compass heading during free gyro (DG) mode operation.
- Fast slaving during operation at extreme latitudes.
- MAG or free gyro (DG) operation mode selection.
- Nulling of compass error after alignment in areas of high magnetic disturbances.

Figure 2-4 Compass Control Unit

The CCU allows crew selection of either DG or slaved magnetic modes. A slaving error annunciator and slew switch are provided for setting the compass heading in DG mode and to provide an indication of synchronization in slaved magnetic mode. The slew switch may also be used to manually correct heading information during operation in extreme latitudes.

4.7.2 Control and Monitoring Device

Only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxxx and -3000):

For operating in navigation mode the system requires the external input of geographical position during gyrocompassing.

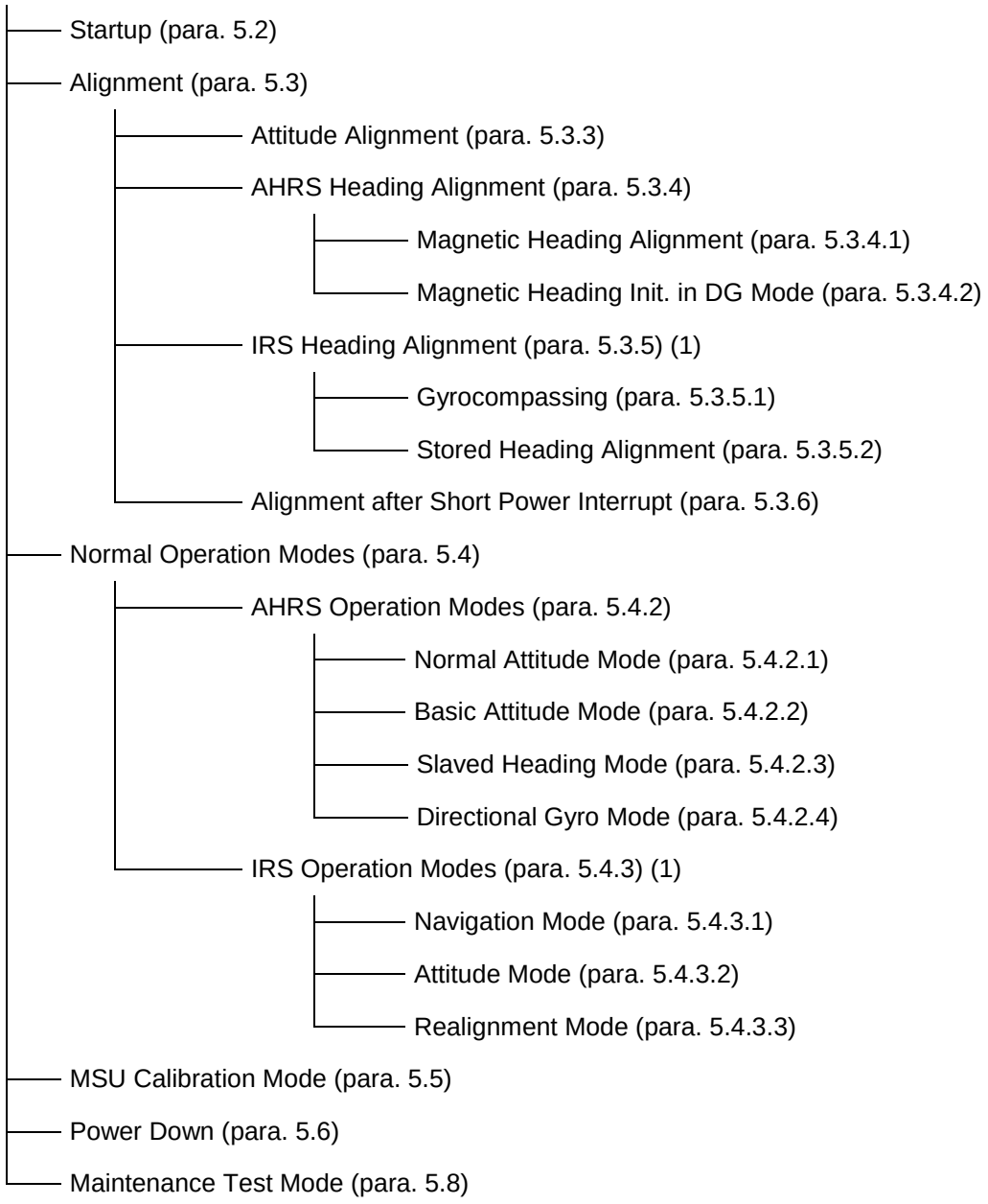
This position can be entered by a CDU (Control and Display Unit) or similar equipment (e.g. FMS (Flight Management System)). Without a position entry the system cannot finish the gyrocompassing.

Applicable for all LCR-100 variants: Other commands like mode selections can be entered by a CDU or switches.

5 Modes of Operation

5.1 Overview and Mode Transition

The system provides the following modes of operation (all cross-references refer to paragraphs in section 2):


Startup (para. 5.2)
Alignment (para. 5.3)
Attitude Alignment (para. 5.3.3)
AHRS Heading Alignment (para. 5.3.4)
Magnetic Heading Alignment (para. 5.3.4.1)
Magnetic Heading Init. in DG Mode (para. 5.3.4.2)
IRS Heading Alignment (para. 5.3.5) (1)
Gyrocompassing (para. 5.3.5.1)
Stored Heading Alignment (para. 5.3.5.2)
Alignment after Short Power Interrupt (para. 5.3.6)
Normal Operation Modes (para. 5.4)
AHRS Operation Modes (para. 5.4.2)
Normal Attitude Mode (para. 5.4.2.1)
Basic Attitude Mode (para. 5.4.2.2)
Slaved Heading Mode (para. 5.4.2.3)
Directional Gyro Mode (para. 5.4.2.4)
IRS Operation Modes (para. 5.4.3) (1)
Navigation Mode (para. 5.4.3.1)
Attitude Mode (para. 5.4.3.2)
Realignment Mode (para. 5.4.3.3)
MSU Calibration Mode (para. 5.5)
Power Down (para. 5.6)
Maintenance Test Mode (para. 5.8)

(1) Only applicable for Gyrocompass AHRS systems (LCR-100 with P/N 145130-1xxx, -2xxx and -3000)

The current operating mode of the system is indicated in the ARINC 429 system discrete status word 270.

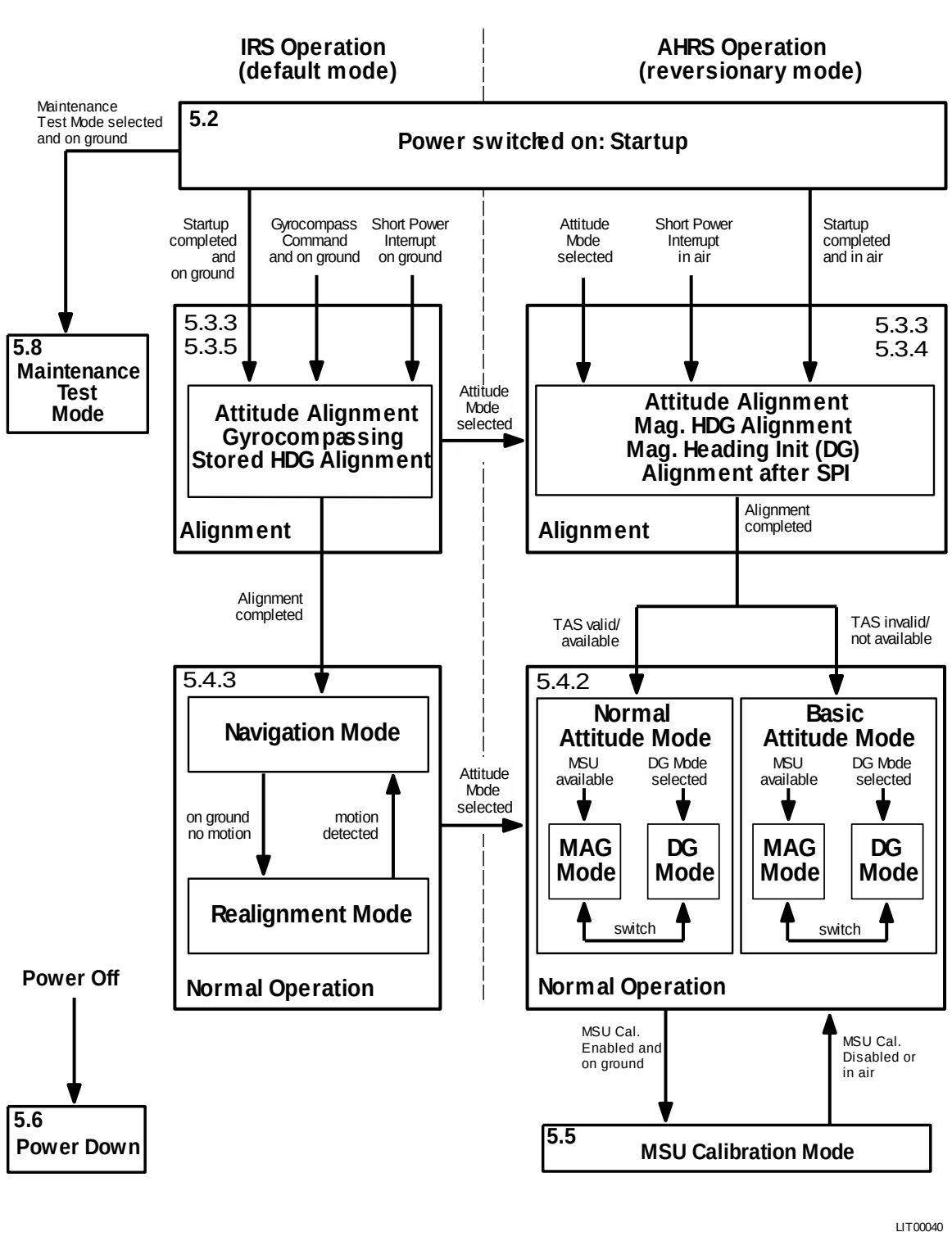


Figure 2-5 Mode Transition Diagram for Gyrocompass AHRS

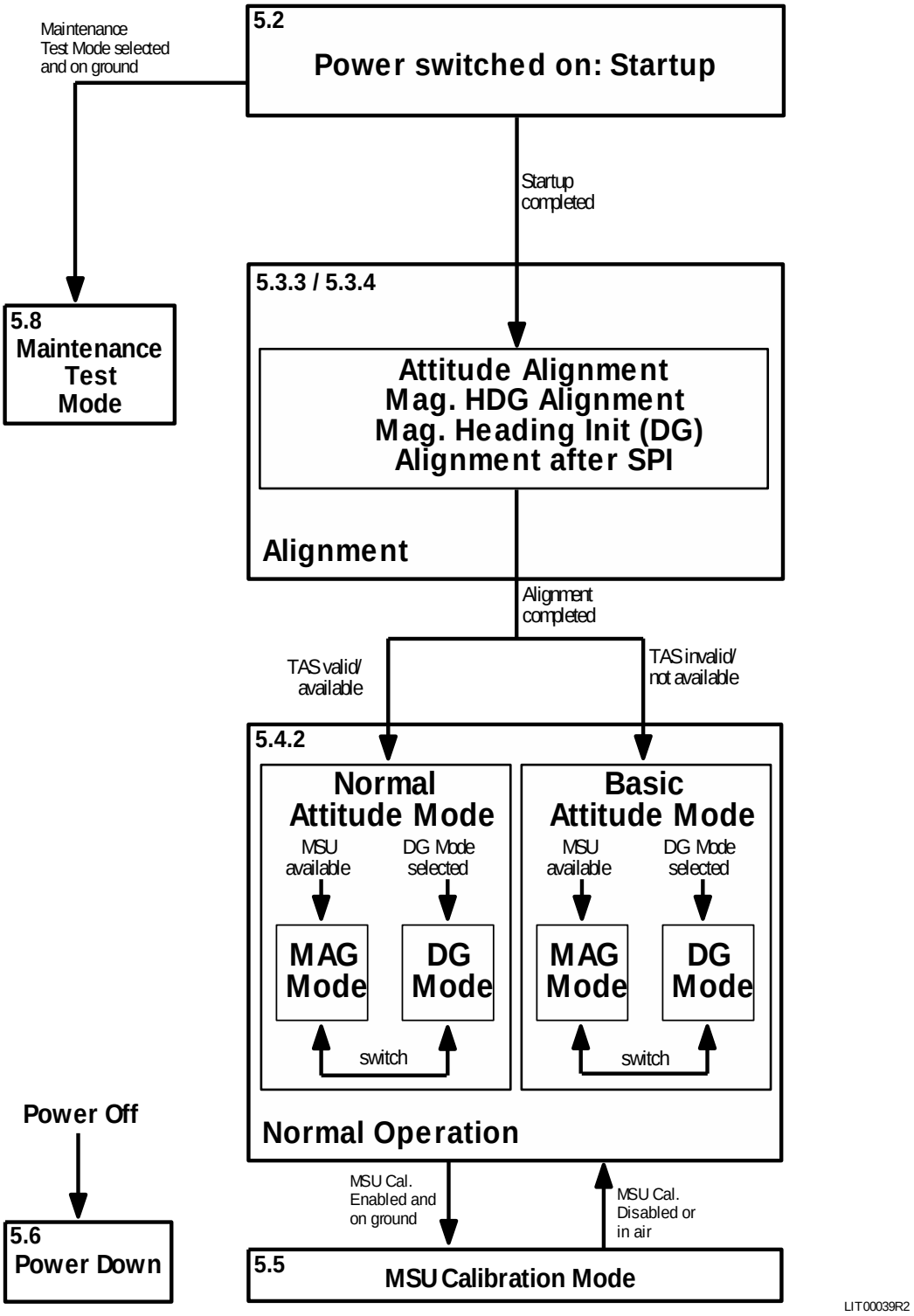


Figure 2-6 Mode Transition Diagram for Standard AHRS

5.1.1 IRS Operation Mode Transitions (Only applicable for Gyrocompass AHRS Systems LCR-100 with P/N 145130-1xxx, -2xxx and 3000)

The default mode transition without input commands and with gyrocompassing conditions is as follows:

Startup – to – IRS Alignment – to – Navigation Mode

The following mode transitions are possible:

Startup – to – IRS Alignment

The system enters the IRS alignment

- after completion of the startup if the aircraft is determined to be on ground.

All Modes – IRS Alignment

The system enters the IRS alignment

- if the gyrocompass command is selected and the aircraft is determined to be on ground.

IRS Alignment – to – Navigation Mode

The system enters the Navigation mode

- if the attitude alignment and the gyrocompassing are finished and the gyrocompassing plausibility test is passed
- or if the stored heading alignment is completed.

IRS Alignment – to – AHRS Alignment

The system switches from IRS to AHRS alignment

- if the attitude mode command is selected.

Navigation Mode – to – Realignment Mode

The system switches from the navigation mode to the realignment mode

- if the aircraft is on ground and no motion is detected.

Navigation Mode – to – Attitude Mode

The system switches from the navigation mode to the attitude mode

- if the attitude mode command is selected.

Realignment Mode – to – Navigation Mode

The system switches from the realignment mode to the navigation mode

- if motion is detected or the aircraft goes in air.

Realignment Mode – to – Attitude Mode

The system switches from the realignment mode to the attitude mode

- if the attitude mode command is selected.

5.1.2 AHRS Operation Mode Transitions

Startup – to – AHRS Alignment

Only applicable for Standard-AHRS systems (LCR-100 P/N 145130-6xxx and -7xxx)

The system enters the AHRS alignment

- after completion of the startup.

Startup – to – AHRS Alignment

Only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000)

The system enters the AHRS alignment

- if the system is powered up in air (incl. short power interrupt)
- or if the attitude mode command is selected.

AHRS Alignment – to – AHRS Operation
The system enters the AHRS operation

- after completion of the AHRS alignment.

AHRS Operation – to – MSU Calibration
The system switches from AHRS operation to the MSU Calibration Mode

- if the MSU Calibration command is selected and the aircraft is determined to be on ground.

MSU Calibration – to – AHRS Operation
The system switches from the MSU Calibration Mode to AHRS operation

- if the MSU Calibration command is deselected
- or if the aircraft is determined to be in air.

5.2 Startup

The startup mode is automatically initiated when the system is powered up. The startup mode comprises the following functions:

- The inertial sensors and all interfaces are initialized and started.
- The user-specified configuration settings stored in the installation data module (IDM) and programmed by the program discretes are loaded.
- The system determines if there was a short or long power interrupt prior to this power on. This information will be needed during the alignment mode to control the alignment process.
- The system determines the status of the ground/air discrete and whether the test mode discrete is set.
- One second after power on, the system continuously monitors and outputs the system status inclusive the system modes of operation.
- During startup the system indicates the aligning / not ready status in Bit 11 of output Label 270. All output data with the exception of the status data (e.g. ARINC Status words) are set invalid. The system performs a power up BIT (PBIT).

Startup time for LCR-100	**Ambient Temperature**	
	0 °C to + 50 °C	< 0 °C or > 50 °C
Startup time for MOD-Status ≤ MOD22	5 s	≤ 25 s
Startup time for MOD-Status ≥ MOD23	6 s	≤ 25 s

Table 2-2 Startup time

The system accepts ARINC command input 2 seconds after power up. After completion of the startup mode the system outputs valid body angular rates and body accelerations.

5.3 Alignment

5.3.1 General

In the alignment mode the attitude and the heading alignment will be performed. Generally there are two different types of heading alignment available, the IRS alignment in which a gyrocompassing is performed and the AHRS alignment in which the magnetic heading will be initiated by a MSU or manually by input commands. The AHRS alignment can be performed on ground and in air.

In the alignment mode the system determines the orientation of the aircraft axes to the local gravity vector and the north direction. The Gyrocompassing finds the true north direction, the alignment with a MSU finds the magnetic north direction. When entering the alignment mode the system determines the status of the air/ground discrete input to set up the alignment conditions.

Attitude and heading alignment are performed simultaneously. The alignment mode is completed if both attitude and heading alignment are completed.

During the attitude alignment, the attitude and heading corresponding status indications (e.g. ARINC SSM, discrete output) are set invalid.

During the heading alignment, the heading corresponding status indications (e.g. ARINC SSM, discrete output) are set invalid.

5.3.2 Alignment Times

The alignment times do not include the startup time (refer to Table 2-2) of the system.

The system estimates and outputs (ARINC Label 305; refer to section 1, paragraph 4.3.2) the remaining alignment time based on the motion condition and the actual position.

Any interruption and restart of the alignment stops the countdown of the timer and resets the timer to the new estimated value. The alignment countdown is started after entering the alignment mode.

It is expected that motion induced by wind buffeting, normal passenger and cargo-loading are within the specified stationary motion condition (refer to Table 2-3) envelope and will therefore not disturb the stationary alignment process.

The following paragraph up to "IRS Alignment" is applicable to LCR-100 System with P/N 145130-1001.

During the entire alignment the system increments the magnetic heading output (ARINC Label 320) by one degree per second starting at zero degree. If the alignment is not completed after 359 seconds (359 deg output), the alignment process indicator continues to increment by one degree per second. At the end of the alignment process the incrementation stops and the true and magnetic heading output provides the estimated heading.

<u>IRS Alignment</u>

The IRS alignment is only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000). It can only be completed if the gyrocompassing is finished or the stored heading alignment has been performed. The alignment time and the true heading accuracy of the gyrocompassing are affected by the latitude at which the system is aligned.

The attitude alignment is finished within 20 seconds.

The system finishes the gyrocompassing within the times defined in Figure 2-7:

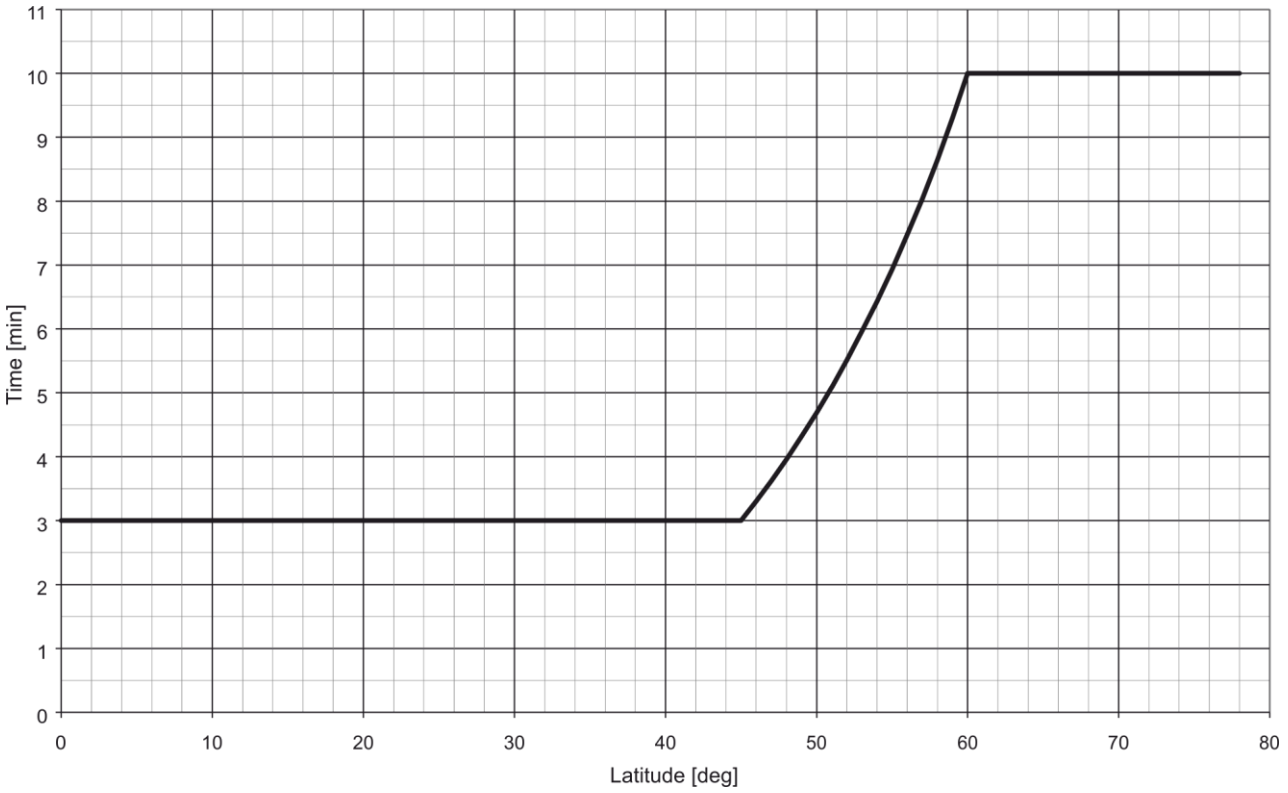


Figure 2-7 Alignment Times for Gyrocompassing

A gyrocompassing will only be performed if no motion is detected. The limitations for the gyrocompassing are defined in Table 2-17.

AHRS Alignment

The AHRS alignment can be performed and completed under limited motion conditions within the time limits as defined in:

- Table 2-3 for all LCR-100 versions up to and including MOD25.
- Table 2-4 for LCR-100 MOD26

The alignment time depends on motion and will increase if the applied motion exceeds the specified limits.

The attitude and heading accuracy after alignment on ground are defined in paragraph 6.2 and 6.3 for static or dynamic conditions. For stationary alignment apply the static accuracy values and for moving alignment the dynamic accuracy values.

The attitude and heading accuracy criteria for moving alignment in air and for on ship is ±2 deg in order to reduce the alignment time.

From MOD 26 on the capability of moving alignment on ships (even with heavy sea) has been improved.

Motion Condition (Up to and including LCR-100 MOD 25)		Attitude	Heading MSU slaved
Stationary Alignment (on ground)			
Angular rates	≤ ± 1°/s	20 s	20 s
Period	≤ 1 s		
Moving Alignment (on ground / in air)			
Angular rates	≤ ± 5°/s (Period ≤ 2 s)	≤ 120 s	≤ 120 s
Acceleration	≤ ± 0.01g		
Heading changes	≤ ± 5° (per 5seconds) (1)		
On Ship Alignment (2)			
Roll/Pitch	≤ ± 8° (Period ≥ 11 s) (ω_{max} = 4.6°/s at 0.09 Hz)	≤ 300 s	≤ 300 s (3)
Acceleration	≤ ± 0.1 g (Period ≥ 11 s)		
Acceleration	≤ ± 0.01 g		
Heading changes	≤ ± 5° (per 5seconds)		

Table 2-3 AHRS Alignment Times under Motion Conditions (up to and including MOD25)

1) If TAS is available the attitude alignment is also performed during turns.
2) Ship speed < 10 kts
3) The ship influence may disturb the earth magnetic field up to ± 180 degrees.

Motion Condition (LCR-100 MOD26)			Attitude	Heading MSU slaved
Stationary Alignment (on ground)				
Angular rates	≤ ± 1°/s		20 s	20 s
Period	≤ 1 s			
Moving Alignment in air				
Angular rates	≤ ± 5°/s (Period ≤ 2 s)		≤ 120 s	≤ 120 s
Acceleration (4)	≤ ± 0.01g			
Heading changes (1)	≤ ± 5° (per 5seconds)			
Moving Alignment On Ship / on ground				
Roll	≤ ± 17.5°	(Period ≥ 11 s)	≤ 300 s	≤ 300 s (2)
Pitch	≤ ± 8°	(Period ≥ 8 s)		
Yaw	≤ ± 5°	(Period ≥ 13 s)		
Acceleration (rotational) (3)	axis x,y,z ≤ ± 0.7 g			
Acceleration (translatory) (4)	≤ ± 0.2 g	(single event with duration < 3s)		
Heading change (turns) (5)	≤ ± 5°	(per 5seconds)		

Table 2-4 AHRS Alignment Times under Motion Conditions (MOD26)

1) If TAS is available the attitude alignment is also performed during turns.
2) The ship influence may disturb the earth magnetic field up to ± 180 degrees.
3) Rotational acceleration - induced by rotation and lever arms (around center of gravity)
4) Translatory acceleration of center of gravity
5) Permanent turns increase alignment times

5.3.3 Attitude Alignment

The system is capable to perform an attitude alignment without any external references within pitch and roll angles of ± 80°.

If aligning in air (AHRS mode) and valid true airspeed (TAS refer to section 2, paragraph 5.9.1) information is available, the system uses TAS to correct for apparent gravity effects.

After completion of the attitude alignment the attitude status indication is set valid.

5.3.4 AHRS Heading Alignment

5.3.4.1 Magnetic Heading Alignment

This paragraph is only applicable if a MSU is available.

The system performs a magnetic heading alignment with means of a MSU if slaved mode (MAG mode) is selected. Switching from DG to MAG mode during attitude alignment restarts the magnetic heading alignment.

The system finishes the magnetic heading alignment if the tilt angle is ≤ ±15°. Temporarily invalid or unusable MSU data due to motion or external disturbances may increase the alignment time.

After completion of the magnetic heading alignment and the attitude alignment the magnetic heading status indication is set valid.

5.3.4.2 Magnetic Heading Initialization (DG Mode)

If powered up in DG mode, the system initializes the magnetic heading to zero degree (north). The magnetic heading is set valid as soon as a heading is entered from external by an ARINC command or by use of the slew discretes (Not applicable for LCR-100 P/N 145130-1001, -1002 and -1005). LCR-100 Systems with P/N 145130-1001, -1002 and -1005 set the magnetic heading valid at the end of the alignment phase without any external command.

5.3.5 IRS Heading Alignment

NOTE

This paragraph with its sub-paragraphs 5.3.5.1 and 5.3.5.2 is only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000).

5.3.5.1 Gyrocompassing

General

The system performs a true heading alignment by gyrocompassing without any external references.

After startup the gyrocompass mode is entered automatically if the conditions for a gyrocompassing are fulfilled and the attitude mode is not commanded. The gyrocompass mode can also be selected manually (refer to section 2, paragraph 5.7.2) to enter the mode during operation. During the gyrocompassing the heading corresponding status indications (e.g. ARINC SSM, discrete output) are set invalid.

In gyrocompassing mode the system accepts position initialization commands (refer to section 2, paragraph 5.7.1). The no position initialization flag in the ARINC 429 discrete word 270 (refer to Table 1-56) is set until the position is initialized.

The gyrocompassing is restarted if a gyrocompass command is received (transition from 0 to 1) during the gyrocompassing. If the gyrocompassing command is still selected at the completion of the gyrocompassing, the system remains in the gyrocompassing mode until the command is deselected.

Gyrocompassing Conditions

The gyrocompassing will be successfully completed at latitudes between 78.25 degrees south and 78.25 degrees north. If the latitude limit of ±78.25 degree is exceeded the system sets the extreme latitude flag in the ARINC 429 discrete word 270 (refer to Table 1-56) and remains in the gyrocompassing mode.

The gyrocompass mode can only be entered if the aircraft is determined to be on ground. The aircraft must remain stationary during gyrocompass alignment. If excessive motion (refer to Table 2-17) is detected, the system sets the excessive motion flag in the ARINC 429 discrete word 270 (refer to Table 1-56) and stops the alignment process. If excessive motion is no longer detected, the system restarts a complete gyrocompass alignment and resets the excessive motion flag.

Alignment Completion Criteria

To complete the gyrocompassing alignment the attitude of the system has to be valid and valid position (latitude and longitude) information has to be available.

If the gyrocompassing was entered by a gyrocompass command during operation, the system uses the previously valid initialization position.

Entering the initial position to complete multiple gyro compassing is necessary only once. The "no position initialization" flag remains "No". After a transition from "in-air" to "on-ground" a commanded gyro compassing needs a position update. The "no position initialization" flag bit 22 in ARINC Label 270 (refer to Table 1-56 and Table 1-58) shall be set to "Yes" until an initial position is available. Independent of the status of flag "no position initialization" a position update is possible all the time during the gyrocompassing phase.

With valid latitude information, the system performs a plausibility test by determining the difference between the estimated horizontal earth rate and the horizontal earth rate calculated from the entered position. This difference is called the north gyro bias error.

The gyrocompassing plausibility test will be passed if the north gyro bias error is less than 1°/h. The gyrocompassing will be completed if the plausibility test is passed.

If the gyrocompassing is completed, the alignment time indications in Label 270 and 305 are set to zero. After a failed plausibility test, the test will be performed again if a new position is entered.

NOTE

The following paragraph is applicable to LCR-100 System with P/N 145130-1001 only.

If the gyrocompass plausibility test at the end of the alignment fails the estimated true heading and a magnetic heading of zero degree is output but still flagged invalid.

5.3.5.2 Stored Heading Alignment

In some applications (e.g. rescue aircraft) a faster alignment is required. If the aircraft has been remained stationary since last power off the stored heading alignment mode can accelerate the time to get into the navigation mode by using the heading stored at last power down.

It is selectable by the stored heading alignment command. This command is accepted only during startup and gyrocompassing. The stored heading alignment mode is indicated with bit 24 in the ARINC discrete word 270 (refer to Table 1-56).

If stored heading alignment is selected during gyrocompassing the system attempts to perform a stored heading alignment. After 90 seconds of gyrocompassing the stored heading alignment mode will be completed if the stored heading plausibility test is passed and position has been entered.

The stored heading plausibility test compares the determined attitude and heading with the data stored at last power down.

The limits of the plausibility test are as follows:

- difference in attitude: 0.25° max.
- difference in heading: 5° max.

The heading comparison of the stored heading plausibility test will be disabled at latitudes higher than 70°.

The gyrocompassing plausibility test and extreme latitude check are disabled for the stored heading alignment.

If the stored heading alignment has been completed successfully the system initializes the heading with the value stored at the last power down.

If the stored heading alignment is completed the alignment time indications in Label 270 and 305 are set to zero.

If the plausibility test of the stored heading alignment fails, the system continues the normal gyrocompassing.

5.3.6 Alignment after Short Power Interrupt (SPI)

The unit will continue to operate normally for a period of time during a power interrupt. This period of time is at least 50 ms. Depending on the system configuration and condition this time period may be longer (e.g. system without synchro module). After this period of time the system shuts down. If the shut down duration is less than 500 ms the system tries to perform a fast realignment.

After power interrupts with duration between 50 ms and 500 ms, the system performs a fast alignment of attitude and heading if following criteria are met:

Estimated attitude change during power interrupt $\leq 5°$

The system will use last valid heading, attitude, body rates and accelerations stored before the power interrupt. The status of the ARINC command input Label 275 before the short power interrupt (SPI) is taken over after the interrupt.

The fast alignment is finished within 100ms after power is applied again.

If the short power interrupt occurs during normal operation the system outputs valid angular rates, attitude and magnetic heading after the fast heading alignment (except magnetic heading at the transition from navigation mode to ATT/MAG mode).

The baro augmentation loop (inertial vertical navigation) and the hybrid platform will be newly initialized after a short power interrupt.

Valid acceleration data is output at latest 1 second after power up.

If the short power interrupt occurs during navigation mode the system operates in attitude mode after the fast alignment. (Only applicable for Gyrocompass AHRS systems LCR-100 with P/N -1xxx, -2xxx and -3000).

Inertial navigation is not possible after a short power interrupt.

If a transition from Navigation mode to ATT/MAG mode occurs the magnetic heading is aligned using MSU input.

During the magnetic heading alignment the magnetic heading is set invalid.

The time of invalid magnetic heading is in the range of 5 to 10s but may increase depending on the validity of the MSU input.

If the short power interrupt occurs during the gyrocompassing the system restarts the gyro-compassing (Only applicable for Gyrocompass AHRS systems P/N -1xxx, -2xxx and -3000).

If the short power interrupt occurs during the realignment mode (on ground and no motion) the system restarts the realignment mode (Only applicable for Gyrocompass AHRS systems P/N -1xxx, -2xxx and -3000).

5.4 Normal Operation Modes

5.4.1 General Functions

Depending on the operational mode and received external data, the system provides different sets of data.

5.4.1.1 Attitude and Heading Reference Data

The system provides the following attitude and heading reference parameter:

- Euler angles (pitch, roll, magnetic heading)
- body rates, Euler rates (pitch, roll, turn)
- body accelerations, along/cross heading accelerations, vertical acceleration

A detailed list of the output parameter is given in Table 1-48.

5.4.1.2 Inertial Vertical Navigation

If the system receives valid pressure altitude information form a digital air data system (DADS), it provides the following inertial vertical navigation parameter:

- inertial vertical speed
- inertial altitude

The system provides a baro-inertial augmentation loop by using the pressure altitude information from the air data computer. If valid pressure altitude is not available for equal or more than 5 seconds, the inertial altitude and inertial vertical speed output are set invalid.

5.4.1.3 Inertial Navigation

This paragraph is only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000).

In addition to attitude and heading reference data the system provides in navigation mode the following inertial calculated IRS data:

- true heading
- position, magnetic variation
- track angle, track angle rate
- drift/flight path angle, flight path acceleration
- wind speed/direction
- N-S / E-W velocities, ground speed
- along/across track acceleration

A detailed list of the output parameter is given in Table 1-49.

In navigation mode the LCR-100 calculates inertial reference data which are referenced to true north without any latitude limitations.

5.4.1.4 Hybrid Navigation

This paragraph is only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000).

If valid GNSS data are received (refer to section 2, paragraph 5.9.2), the system provides the following hybrid data which are augmented by the GNSS information:

- Hybrid true heading
- Hybrid position
- Hybrid track angle, hybrid track angle rate
- Hybrid drift/flight path angle, hybrid flight path acceleration
- Hybrid Wind speed /direction
- Hybrid N-S / E-W velocities, ground speed
- Hybrid along/across heading velocities
- Hybrid altitude, hybrid vertical velocity

A detailed list of the output parameter is given in Table 1-50 and Table 1-51.

The output of the hybrid data only starts if a GNSS receiver is detected (by receiving the GNSS status Label 273) and the allocated time mark signal is available. For LCR-100 with P/N 145130-3000 also valid GNSS lever arm data hast to be stored to enable hybrid data output.

Once the hybrid output data has been started, it continuous during the complete power-on cycle. Hybrid navigation is performed in normal operation modes (e.g. navigation mode and attitude mode).

The calculation of the hybrid navigation data is initialized with valid attitude and heading after completion of the alignment and if valid GNSS data with allocated time mark are available. If the heading alignment was performed successfully in IRS heading alignment mode the hybrid navigation data is set valid.

In order to achieve the full specified hybrid performance after AHRS alignment mode or after a re-initialization of the hybrid calculation a GNSS moving alignment is performed. The GNSS moving alignment time depends on the flight dynamic. Under typical flight dynamic the duration is in a range of 10 to 30 seconds.

NOTE

The following sentence is valid for all LCR-100 versions up to and including MOD Status 22, except P/N 145130-1002.

If the heading alignment was performed in AHRS alignment mode the hybrid navigation data is set valid after successful heading verification by the GNSS moving alignment.

--- End of note

NOTE

The following sentence is valid for all LCR-100 versions with MOD Status ≥ 23, except P/N 145130-1002 and -1005.

During the hybrid moving alignment the system shall set the hybrid output data (hybrid position, hybrid velocities) valid except for hybrid heading.During the hybrid moving alignment the system sets the hybrid output data hybrid position and hybrid velocities valid except for hybrid heading.

--- End of note

NOTE

The following sentence is only valid for LCR-100 P/N 145130-1002 and -1005.

If the heading alignment was performed in AHRS alignment mode the hybrid navigation data is set valid directly after the AHRS alignment.

--- End of note

After loss of valid horizontal GNSS data or loss of the allocated time mark the system computes the horizontal hybrid navigation data free inertial and outputs valid hybrid data.

The related hybrid data is set invalid if the estimated hybrid accuracies exceed one of the following criteria:

- velocity > 1 m/s,
- position > 66 m
- heading > 5 degree

or if the elapsed time without valid GNSS data exceeds 600 sec. (Only P/N 145130-1002 and -1005.)

If the vertical GNSS data are not available the vertical hybrid data is augmented by the pressure altitude input and added pressure altitude offset. If both vertical GNSS data and pressure altitude data are not available the vertical hybrid data is set invalid.

If the divergence between the GNSS solution and the hybrid solution exceeds certain limits the hybrid navigation data is set invalid and a new initialization followed by a moving alignment of the hybrid navigation is performed.

A new initialization can occur after alignment in AHRS alignment mode with large heading errors (e.g. corrupted flux valve data or wrong heading input in DG mode).

In attitude mode a moving alignment will be necessary. The time of invalid hybrid data increases accordingly.

The system performs plausibility checks to avoid augmentation with wrong GNSS data. After 30 seconds of continuously failed plausibility check the system re-initializes the hybrid platform.

Long term error

The system estimates long term errors of the inertial instruments by using GNSS data. For the long term sensor error estimation feature, the complete GNSS data-set is required (refer to Table 1-34). If the GNSS data of the vertical channel are missing, the performance of the long term error estimation is reduced. The currently estimated inertial instrument errors are used to improve the hybrid navigation performance (hybrid platform). Based on currently estimated sensor errors long term errors are derived and stored.

Before storing the long term error compensation data, a plausibility test of the long term errors is performed. If the plausibility test fails the compensation data is not updated. The long term compensation data are limited to a value that does not affect the safety criteria of the attitude output. The stored long term error compensation data is used to improve the inertial navigation performance.

The GNSS and hybrid data have no other influence to the inertial platform than initialization of the inertial position and the long term error scale factor compensation.

The system calculates and outputs the Figure of Merit (FOM) of the hybrid position data as a 1 σ value - in case of P/N 145130-3000 as a 95% value. It calculates the hybrid reference data which are referenced to true north without latitude limitations.

5.4.2 AHRS Operation Modes

The AHRS operation modes are the normal operational modes of the Standard-AHRS LCR-100 systems (LCR-100 P/N 145130-6xxx and -7xxx) (refer to Figure 2-6).

For LCR-100 Gyrocompass AHRS systems (LCR-100 P/N145130-1xxx, -2xxx and -3000) the AHRS mode is one of two possible modes. This systems operate as AHRS (without gyrocompassing) when attitude mode is selected (refer to Figure 2-5) or after startup in air. The attitude mode is the reversionary mode of this system.

5.4.2.1 Normal Attitude Mode

In normal attitude mode the system determines the attitude by a Schuler loop inertial platform mechanization using true airspeed augmentation.

The normal attitude mode will be activated as long as the aircraft is determined to be in air and valid true airspeed (refer to section 2, paragraph 5.9.1) information is available or if the aircraft is determined to be on ground after power on. If the normal attitude mode conditions disappear in air, the system switches to basic attitude mode after a maximum of 5 minutes.

If the normal attitude mode is activated at landing, it will remain active on ground.

5.4.2.2 Basic Attitude Mode

In basic attitude mode the system determines the attitude autonomously without external augmentation by using the direct gravity coupling method.

The basic attitude mode will be activated 30 s after take off if valid TAS is not available. If the conditions for operating in normal attitude mode are met (TAS valid, refer to section 2, paragraph 5.9.1), the system switches to the normal attitude mode after a maximum of 5 seconds.

If the basic attitude mode is activated at landing, it will remain activate on ground.

5.4.2.3 Slaved Heading Mode (MAG)

If no MSU is detected at power on the system disables the MAG mode. Not applicable to LCR-100 P/N 145130-1001 and LCR-100 Standard AHRS systems (P/N145130-6xxx and -7xxx)

In Slaved Mode the magnetic heading output of the AHRU is augmented by a Magnetic Sensor Unit (MSU). The MSU is used as a long term reference in this case, while the gyros within the AHRS provide the required short term stability to provide accurate magnetic heading information under dynamic flight conditions and in turns.

To avoid autopilot cutoffs the maximum slaving rate does not exceed 0.5 deg/s.

The slaved mode (MAG) is manually selectable. When entering the MAG mode manually, the magnetic heading is initiated with the value of the MSU heading input (provided that the MSU heading is considered as valid).

If the MSU heading input is not valid (e.g. due to maneuvers or MSU errors or invalid or missing MSU signal) when entering the MAG mode, the magnetic heading is set invalid until the MSU heading input is considered as valid.

In order to remove a slaving error manually (difference between the magnetic sensor input and the platform heading) the magnetic heading output can be synchronized to the MSU heading input by activating one of the slew discretes.

The magnetic heading output can also be synchronized to the MSU heading by switching from MAG mode to DG mode and back to MAG mode via ARINC 429 command or by the DG/MAG mode select discrete.

The impact of magnetic disturbances at landing sites after an in air to on ground transition is minimized.

5.4.2.4 Directional Gyro Mode (DG)

In DG Mode the system provides platform heading on magnetic heading output. The platform heading is calculated without any MSU augmentation and without vertical transport rate compensation.

The DG Mode is manually selectable.

If no MSU is detected at power on, the system operates in DG mode independent on the DG/MAG mode discrete. Not applicable to LCR-100 P/N 145130-1001 and LCR-100 Standard AHRS systems (P/N145130-6xxx and -7xxx).

If the DG mode is entered during operation (e.g. MAG/DG transition or NAV/DG transition) or after a short power interrupt the system takes over the last valid magnetic heading and set the magnetic heading output valid.

The system accepts magnetic heading slew commands (refer to section 2, paragraph 5.7.2) and the magnetic heading set command (refer to section 2, paragraph 5.7.1).

5.4.3 IRS Operation Modes

NOTE

This paragraph with its sub-paragraphs 5.4.3.1, 5.4.3.2 and 5.4.3.3 is only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000).

5.4.3.1 Navigation Mode

The navigation mode will be entered after successful completion of a gyrocompassing or stored heading alignment.

In navigation mode the system performs unaided Schuler - tuned inertial navigation, providing outputs of aircraft attitude, body rates and accelerations, true and magnetic heading, velocity vectors and present position.

The system subtracts magnetic variation (which is computed from the current WMM earth magnetic field model) from true heading and true track to produce magnetic heading and magnetic track angle

To achieve the best accuracy of the WMM model the use of the current date is recommended for the calculation of the magnetic variation. If available, the system uses an external input date for the calculation of the magnetic variation either from the FMS input or - if the FMS is not available - from the GNSS input in case of indicating full operation (Note: GPS input is used from and including MOD-Status 20). If no date from external is available, the system uses the stored default date. The default date is the center date of the time span of the used WMM model.

In navigation mode on ground the system accepts position initialization commands (see section 2, para. 5.7.1)

If DG Mode is selected by the DG/MAG Mode selection command (see section 2, paragraph 5.7.2) the system provides platform heading on magnetic heading output.

After selection of DG Mode the platform heading is initialized with the current true heading.

The platform heading is calculated without any augmentation and without vertical transport rate compensation.

NOTE

During the NAV/DG operation the normal navigation mode is calculated in the background. After switching back to NAV/MAG mode the true heading is available again with transport rate compensation.

The platform heading is adjustable by slew input discretes (see section 2, paragraph 5.7.2) or the magnetic heading set command (section 2, paragraph 5.7.1)

An attitude mode command terminates the navigation mode.

5.4.3.2 Attitude Mode

The attitude mode is the reversionary mode if navigation mode is not possible. It provides a rapid attitude and heading restart when the system loses the navigation mode by a temporary power loss or BIT detects excessive errors. The attitude mode is not a self-contained mode. In this mode the system operates in the AHRS modes defined in section 2, paragraph 5.4.2.

The attitude mode will be entered if the system is determined to be in air at startup or if the system receives the attitude mode command (refer to section 2, paragraph 5.7.2). On ground the attitude mode (ATT) can only be entered manually by the attitude mode command. The attitude alignment is performed as defined in section 2, paragraph 5.3.3. If the system enters the ATT/MAG mode, the heading will be aligned as defined in section 2, paragraph 5.3.4.1. If the system enters the ATT/DG mode, the heading will be aligned as defined in section 2, paragraph 5.3.4.2.

In attitude mode the inertial true heading information (Label 314) and all IRS data are set invalid. Once the attitude mode is entered, the system remains in attitude mode independent of the attitude mode command.

The attitude mode is terminated only by system power off or if the gyrocompass command is received when the aircraft is determined to be on ground and the attitude mode command is not set.

5.4.3.3 Realignment Mode

The realignment mode will be initiated automatically if:

- the system is in navigation mode,
- the aircraft is on ground
- and no motion is detected.

During the realignment all inertial output data remain valid. In realignment mode the system accepts position initialization commands (refer to section 2, paragraph 5.7.1). The realignment mode is indicated in the ARINC 429 discrete word 270 (refer to Table 1-56). In realignment mode the system zeros residual velocity errors accumulated in the previous operation and re-level pitch and roll.

In realignment mode the system performs a new heading estimation gyrocompassing as specified in section 2, paragraph 5.3.5.1 in the background. If the alignment completion criteria are fulfilled the heading output is updated with the new estimated heading. The remaining time until the first update of the heading is estimated and indicated in Label 305 (ARINC Label 305; refer to section 1, paragraph 4.3.2).

After the first heading update the heading estimation continues and the heading is further updated by the estimated heading.

During the first realignment after a successful gyrocompassing alignment the heading estimation is continued and the heading output is updated by the estimated heading.

If excessive motion (definition: refer to Table 2-17) is detected, the system switches back to the navigation mode.

5.5 MSU Calibration Mode

NOTE

This paragraph incl. para.5.5.1and 5.5.2 is only applicable with installed MSU!

5.5.1 Compass Swing

The system is able to perform a MSU calibration by a compass swing of the aircraft without a special maintenance tool. (For further information about MSU Calibration: refer to section 1, paragraph 7.)

The calibration mode will be activated by the MSU calibration discrete (refer to section 1, paragraph 4.2.1.3) or by the mode button, provided that:

- the alignment is completed
- the aircraft is determined to be on ground (ground/air discrete is set for aircraft on ground)
- a MSU is detected at power on
- no motion is detected.

Please press the mode button longer than 2 seconds! The MSU calibration mode is indicated by a continuous illuminating of the LED at the front plate of the system. If the LED flashes, this indicates a fault and it is not possible to enter MSU calibration mode.

During the MSU Calibration Mode the system indicates DG mode operation on the related output (e.g. Bit 14 in Label 270). The system transits from MSU calibration mode to normal operation if the ground/air discrete (refer to section 1, paragraph 4.2.1.3) is set to in air condition.

In MSU calibration mode the system determines the coefficients used for compensation of single and dual cycle MSU errors. The MSU calibration algorithm is able to compensate MSU errors (sum of single and dual cycle errors) of up to 12 degrees. The attitude warn and heading warn flags are set to invalid condition. The heading output outputs uncompensated MSU input data until the aircraft is moved.

During the execution of the Compass Swing Procedure heading data are collected (Compass Swing Procedure: refer to section 1, paragraph 4.2.1.3). Data collecting is complete after turning through 315 deg (7 steps of 45 deg). After collecting the complete data, the calibration coefficients for single and dual cycle errors are calculated and stored in the IDM.

After successful MSU calibration the heading warn flag is set valid. If the MSU calibration was not successful or terminated prematurely, the calibration coefficients are not stored in the IDM. The former coefficients are available again after the MSU calibration mode has been left.

The system leaves the MSU calibration mode if the MSU calibration discrete is switched from enabled to disabled. If the MSU calibration mode has been entered by the mode button (MSU calibration discrete disabled), the system automatically leaves the MSU calibration mode 10 s after indication of the residual heading error or if the mode button has been activated again (pressed longer than 2 s).

5.5.2 Index Error Compensation

After the Compass Swing, index error compensation is recommended. The system is able to program MSU index error compensation data manually via the Slew Left / Slew Right commands (refer to section 2, paragraph 5.7.2) or by the Set Magnetic Heading Command (ARINC 429 Label 043), if the DG-Mode command is received while the system is in MSU Calibration Mode.

If the index error compensation is performed by the Slew Left / Slew Right commands (refer to section 2, paragraph 5.7.2), the error compensation will be incremented in 0.1° steps with a rate of 0.3°/s accordingly. The index error compensation is limited to a maximum of plus/minus 5°. By switching from DG to MAG mode, the index error compensation data are stored. If there is no DG to MAG mode transition before leaving the MSU calibration mode, the new index error compensation value will be rejected.

5.6 Power Down

The Power Down will be initiated automatically as soon as the system input power drops below the value specified in section 1, paragraph 1.5.

In order to enable a fast alignment after short power interrupts (refer to section 2, paragraph 5.3.6) or the stored heading alignment the system stores the last valid heading (true and magnetic), attitude, body rates, body accelerations, Air/Ground status, position, command Label 275, and the motion status in a non volatile memory during power down.

5.7 System Input Commands

5.7.1 Initialization Commands

To enter the initialization commands, more than one entry is necessary. The system accepts the initialization commands if two successive identical entries are received within 3 seconds.

Position Initialization / Update

This command is only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000). Position Initialization is only accepted on ground.

For the position initialization the system accepts:

- manual position commands via ARINC 429 Input Bus No. 5 or 6 (refer to section 1, paragraph 4.3.1.4) or
- GNSS position information received via ARINC 429 Input Bus No. 1, 3 or 4 (refer to section 1, paragraph 4.3.1.3).

If position information is received on several input channels, the priority is as defined in Table 2-5 starting with the highest priority 1.

Priority	**1**	**2**	**3**	**4**	**5**
Input channel	5 (FMS/CCU1)	6 (FMS/CCU2)	1 (DADS1)	3 (GNSS1)	4 (GNSS2)

Table 2-5 Position Initialization Priority

GNSS position is only used as initialization position if no manual position has been entered since power on or since the last air to ground transition.

Magnetic Heading Initialization

In DG mode the system accepts a manual heading set command by the ARINC 429 command Label 043 (refer to Table 1-43) on ARINC 429 Input Data Bus No. 5 and 6. With active Index Error Compensation (refer to section 2, paragraph 5.5), the heading set command will be used to compensate the MSU Index error. The input data bus No. 5 has the higher priority.

5.7.2 Discrete / ARINC 429 Commands

If not stated otherwise, the commands defined in this paragraph are accepted either via discrete input or via ARINC 429 input Label 275 on data bus No. 5 and 6 (refer to section 1, paragraph 4.3.1.4).
The ARINC 429 input commands are enabled by command enable bits in the command discrete word Label 275 (refer to section 1, paragraph 4.3.1.4). As long as an ARINC 429 command is enabled, the related discrete input is disabled.

Selftest Data Output Command

The selftest data output will be activated if the selftest data output command is received (discrete or ARINC 429) and the aircraft is determined to be on ground (e.g. ground/air discrete). If the selftest data output is active, the system outputs defined values on its digital and analog data outputs as well as discrete and validity settings (refer to section 1, paragraph 5.1).

The system transits from self test data output to normal operational data output within one second, if the selftest data output command is disabled or the ground/air discrete is set to in air condition.

DG/MAG Mode Selection

During AHRS operation the system operates either in MAG or DG mode (refer to section 2, paragraph 5.4.2.3 and 5.4.2.4) depending on the status of the DG/MAG mode selection command (discrete or ARINC 429). In AHRS operation this command is applicable only if a MSU is available; for LCR-100 system with P/N 145130-1001 it is independent of the availability of the MSU.

In navigation mode the system determines the magnetic heading depending on the status of the DG/MAG mode selection command (discrete or ARINC 429) as defined in section 2, paragraph 5.4.3.1. Only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000).

Magnetic Heading Slew

This command is available as discrete input only.

If DG mode is selected, the system accepts manual heading slew left and slew right commands.

NOTE

slew left = magnetic heading value decreasing
slew right = magnetic heading value increasing

The slew rate will be 2 deg/s for the first 3 seconds and 8 deg/s after 3 seconds continuous slewing.

Stored Heading Alignment Command

This command is only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000) and it is only accepted if the aircraft is determined to be on ground.

The system enters the stored heading alignment mode (refer to section 2, paragraph 5.3.5.2) if the stored heading alignment command is received (discrete or ARINC 429). If the discrete input is activated, the command will be accepted if the stored heading alignment discrete is set for at least 2 seconds (refer to section 1, paragraph 4.2.1.3).

Gyrocompass Command

This command is only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000) and it is only accepted if the aircraft is determined to be on ground.

The system enters the gyrocompassing mode (refer to section 2, paragraph 5.3.5.1) if the gyrocompass command is received (discrete or ARINC 429). If the discrete input is activated the command will be accepted if the gyrocompass mode select discrete is set for at least 2 seconds.

Attitude Mode Command

This command is only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000).

The system enters the attitude mode (refer to section 2, paragraph 5.4.3.2) if the attitude mode command is received (discrete or ARINC 429). If the discrete input is activated, the command will be accepted if the attitude mode discrete is set for at least 2 seconds (refer to section 1, paragraph 4.2.1.3).

DADS 1/2 Select Command

The system accepts the DADS 1 or 2 input either automatically, or forced or no input (BASIC Mode) according to Table 1-45 (discrete or ARINC 429).

Hybrid GNSS Augmentation

If the Hybrid GNSS augmentation bit (Label 275 bit 27) is set the system disables the augmentation by GNSS (ARINC 429).

Re-Initialization of Hybrid Kalman Filter

This command is available at P/N 145130-3000 only.

If the Re-Initialization of Hybrid Kalman Filter bit (Label 275 bit 28) is selected the system re-initializes the hybrid Kalman Filter (ARINC 429).

The re-initialization starts a realignment of the hybrid platform. All hybrid output labels except 274 are set to NCD until realignment is completed.

5.7.3 Normal Acceleration Test Enable

When the Normal Acceleration Test Enable Discrete (refer to section 1, paragraph 4.2.1.3) is set the system sets the Normal Acceleration DC Output (refer to section 1, paragraph 4.4.2.3) to 0.0 VDC (= 0.0 g) independent of the Air/Ground status.

The self test data command on ground supersedes the Normal Acceleration Test output.

5.8 Maintenance Test Mode

The maintenance test mode will be entered at power up when the test mode discrete (refer to section 1, paragraph 4.2.1.3) is set and the aircraft is determined to be on ground (e.g. ground/air discrete).

In maintenance test mode, the test and maintenance interface is activated. It is recommended to use the Northrop Grumman LITEF GmbH Level 1 Maintenance Set. Once in maintenance test mode, the system is not able to switch to any other mode except the Power Down mode. **The system has to be cycled through the off-state to return to normal operation.**

In maintenance test mode all data on the operational output (e.g. ARINC 429, and warn discretes) are flagged invalid all the time. In maintenance test mode BIT-History can be read out. Further maintenance test mode capabilities and functions are described in section 3, paragraph 4.3.

5.9 Augmentation Validity

5.9.1 Digital Air Data System (DADS)

If the system is supplied with DADS data, these data will be set valid under the following conditions:

	Parity and SSM (1)	Input range	Step change (2)	Difference of input (3)
True Airspeed (TAS):	valid	50 .. 700 kts	< 14 kts	< 12 kts
Pressure Altitude	valid	-1,500 .. 65,617 ft	< 27 ft	< 320 ft

Table 2-6 Conditions for DADS data to be set valid

1) applicable for ARINC 429 data, refer to section 1, paragraph 4.3.1.2

2) The input data of the step change check is low pass filtered (time constant: TAS 0.368 S; pressure altitude 0.468 s)

3) Difference of input checks will be performed only if two Digital Air Data systems are connected and both deliver valid data. For variants with manual DADS selection function the check will only be performed if the automatic DADS selection is active.

5.9.2 Global Navigation Satellite System (GNSS)

If the system is supplied with GNSS data these data will be set valid if an appropriate time mark signal on the allocated time mark input is available.

If a RAIM signal is available, the system uses the GNSS data only if the RAIM has no failure detected. If the horizontal integrity limit is available by the GNSS receiver the system uses the GNSS data only if the horizontal integrity limit is better than 2 nm.

If the input rate of the GNSS data is higher than the time mark frequency (1Hz) the first data set after receiving the time mark signal is used (Not applicable to P/N 145130-1002 and -1005).

If the input rate of the GNSS data is higher than the time mark frequency (1Hz) only the latest data set is used which is received before the "GNSS maximum delay time" is elapsed (Only applicable to P/N 145130-1002 and -1005)

The parameter "GNSS maximum delay time" is stored in the IDM. Its limits are: 100 to 900 ms. If no value is programmed to the IDM the default value is 900 ms.

6 System Performance

NOTE

All technical data concerning accuracy of LCR-100 Gyrocompass AHRS mentioned in this manual refer to an original LCR-100 type Mounting Tray (P/N 145137-0100 or 145138-0100).

The LCR-92/93 Mounting Tray (standard: P/N 124260-0000 or 140691-0000, ruggedized: P/N 144200-0000 or 144201-0000) can also be used for LCR-100 (concerning the outlines).

With an LCR-92/93 type Mounting Tray (standard or ruggedized version) Northrop Grumman LITEF GmbH does not guaranty to achieve the specified accuracy for the Gyrocompass AHRS (LCR-100 P/N 145130-1xxx, -2xxx and -3000).

The specified accuracy for the Standard AHRS LCR-100 system (P/N 145130-6xxx and -7xxx) does not depend on the Mounting Tray used.

The following defined accuracies are valid for fault free augmentation input data.

6.1 General Definitions

Static Condition (Straight and level flight)

For some parameter the performance is differentiated between static and dynamic conditions:

Parameter	Static Condition	Dynamic Condition
Acceleration	< 0.2 g (magnitude of vector)	≥ 0.2 g (magnitude of vector)
Rates	< 5.0°/s (magnitude of vector)	≥ 5.0°/s (magnitude of vector)
Pitch / Roll	< 15° (in both directions)	≥ 15° (in both directions)
Heading Change	no continuous turns	continuous turns

Table 2-7 Static / Dynamic Conditions

6.2 Attitude Accuracy

Pitch/Roll	IRS Operation (Navigation Mode)	AHRS Operation (Attitude Mode)	
		Basic Attitude Mode	Normal Attitude Mode
Static	0.1 deg (max)	0.5 deg (max) 0.3 deg (95%)	0.5 deg (max) 0.3 deg (95%)
Dynamic	0.2 deg (95%)	1.0 deg (95%)	0.5 deg (95%)

Table 2-8 Attitude Accuracy

6.3 Heading Accuracy

Parameter	**AHRS Operation (Attitude Mode)** all values 95%	
	MAG Mode (1)	**DG Mode (2)**
Magnetic Heading		
Static Conditions	1.0 deg	5.0 deg/h
Dynamic Conditions	2.0 deg	5.0 deg/h + 1000 ppm

Parameter	**IRS Operation (Navigation Mode)** all values 95%			
	P/N 145130-1xxx; -2xxx, -3000 (except 145130-1002 and -1005)		**P/N 145130-1002 and -1005**	
True Heading				
Gyrocompassing accuracy (3)	1.0 deg	< 60 deg latitude	1.8 deg	< 60 deg latitude
	1.5 deg	60 - 70 deg latitude	2.5 deg	60 - 70 deg latitude
	2.0 deg	70 - 75 deg latitude	3.3 deg	70 - 75 deg latitude
	2.4 deg	75 - 78.25 deg latitude	4.2 deg	75 - 78.25 deg latitude
Additional Heading error during a 3 hour flight	1.0 deg	< 60 deg latitude	1.8 deg	< 60 deg latitude
	1.5 deg	60 - 70 deg latitude	2.7 deg	60 - 70 deg latitude
	1.8 deg	70 - 75 deg latitude	3.2 deg	70 - 75 deg latitude
	2.0 deg	75 - 78.25 deg latitude	3.6 deg	75 - 78.25 deg latitude
Magnetic Heading				
	True heading error plus world magnetic field model error (4)			

Table 2-9 Heading Accuracy

1) In MAG mode the heading accuracy is related to the local magnetic field.

2) The DG mode accuracies are given if latitude estimation is available. The latitude will be estimated at alignment on ground or after alignment in air during straight and level flight if a MSU is available. Otherwise the drift may increase up to 15 deg/h.

3) An additional heading error may occur due to gyro scale factor error (1000 ppm 95%). This additional error depends on the flight maneuvers
The long term scale factor error can be bounded to 200 ppm (95%) by GNSS augmentation. The GNSS augmentation requires the data defined in of a GNSS receiver on one of the GNSS ARINC 429 input data buses and the time mark signal of this receiver on the associated time mark input. The lever arm of the GNSS antenna to the AHRU should be entered in the IDM to maximize the error compensation capability.

4) The used model is the NOAA world magnetic field model. The error of the model varies with different locations and can increase up to 2 deg. The errors are described in detail in the NOAA Technical Report NESDIS/NGDC. To minimize the error the input of the current date to the system is recommended. The model cannot account for local anomalies.

6.4 Body Rates and Acceleration Accuracy

The system is able to measure angular rates around the three main axes up to 600°/s. and accelerations in the three main axes up to 10g.

Parameter	**IRS Operation (Navigation Mode) and AHRS Operation (Attitude Mode)** all values 95%	
Body Rates (x, y, z)	0.02 deg/s or 0.5 %	Whichever is greater
Euler Rates (Pitch, Roll, Turn)	0.02 deg/s or 0.5 %	Whichever is greater
Body Accelerations	5 mg or 0.5 %	Whichever is greater
Vertical Acceleration	5 mg or 0.5 %	Whichever is greater
Along/ Across Heading Acceleration	10 %	

Table 2-10 Angular Rates and Acceleration Accuracy

6.5 Vertical Navigation Accuracy

Parameter	**IRS Operation (Navigation Mode) and AHRS Operation (Attitude Mode)** all values 95%	
Inertial Altitude	5 ft	Accuracy specified with constant altitude input and filter at steady state with no error assumed in air data input
Inertial Vertical Speed	30 ft/min	

Table 2-11 Vertical Navigation Accuracy

6.6 Inertial Navigation Accuracy

Only applicable for LCR100-Gyrocompass Systems (P/N 145130-1xxx, -2xxx and -3000).

Parameter	**IRS Operation (Navigation Mode) only** all values 95%	
Position	12 nm/h 2 nm/15 minutes	Position Drift Position Drift after entering Navigation Mode (P/N: 145130-3000 only)
Ground Speed	24 kts	
N-S / E-W Velocities	24 kts	
Along / Across Track horizontal Accelerations	10 %	
Flight Path Angle	2 deg 4 deg	Accuracy specified for flight path angle <10 deg and for Ground Speed > 120 kts. Accuracy specified for flight path angle between 10 and 20 deg and for Ground Speed > 120 kts. With extreme flight path angles and low ground speed the error can increase to any value
Flight Path Acceleration	10 %	
Track Angle True	10 deg	Accuracy specified for Ground speed > 120 kts

Parameter	**IRS Operation (Navigation Mode) only** all values 95%	
Track Angle MAG	10 deg	Accuracy specified for Ground speed > 120 kts, Accuracy depends on MagVar model
Track Angle Rate	0.25 deg/s	
Wind Speed	24 kts	(1)
Wind Direction	20 deg	(1) Accuracy specified for wind speed > 24 kts
Drift Angle	10 deg	Accuracy specified for Ground speed > 120 kts
Potential Vertical Speed	30 ft/min	

Table 2-12 Inertial Navigation Accuracy

1) No error assumed in DADS TAS input and bank angle <35 deg.

The inertial navigation performance can only be guaranteed if a gyrocompassing with an accuracy of 1° has been performed (refer to Figure 2-7 and Table 2-17).

6.7 Hybrid Navigation Accuracy

Only applicable for LCR-100 Gyrocompass systems (P/N 145130-1xxx, -2xxx and -3000).

All accuracies of GNSS dependent output data (hybrid data) are specified for static conditions under the following prerequisites:

GNSS Receiver:	in accordance with ARINC 743/743A/743A-5
Time Mark Pulse:	available in accordance with ARINC 743/743A/743A-5
GNSS PDOP:	< 3.0
2d-position (2dRMS) accuracy:	30m, S/A off
GNSS velocity accuracy:	2kts (95%), S/A off
Accuracy of programmed GNSS antenna lever arm: (Location of GNSS antenna with respect to center of inertial measurement):	< 0.1m

To achieve the hybrid accuracies after dynamic flight conditions it is necessary to fly the aircraft straight and level (refer to paragraph 6.1) for 3 minutes.

In accordance to ARINC 743A-5 the GNSS receiver has to compute and to provide an estimate of position, time and velocity that is coincident in time. To ensure a proper synchronization between the GNSS input and the inertial data, both position and velocity must be referenced to a known point of time, when the data set were valid. In order to get best performance it is essential to know the exact point of time when the data was valid and to get instantaneous values to the greatest possible extent.

Parameter	**IRS Operation (Navigation Mode) and AHRS Operation (Attitude Mode)** all values 95%	
Hybrid True Heading	0.5 deg	
Hybrid Position	GNSS accuracy typical 3m 4 nm	GNSS augmented (1) 1 hour after loss of GNNS augmentation Prerequisite: 30 minutes of GNSS augmentation including dynamic aircraft operation with a turn of 360° independent of the turn direction (The turn needs not to be performed in one maneuver)
Hybrid Ground Speed	0.5 kts 1.0 kts	Static Dynamic
Hybrid N-S / E-W Velocities	0.5 kts 1.0 kts	Static Dynamic
Hybrid Along / Across Heading Velocities	0.5 kts 1.0 kts	Static Dynamic
Hybrid Flight Path Angle	0.5 deg	Accuracy specified for Ground speed > 120 kts
Hybrid Flight Path Acceleration	5 mg or 2 %	Whichever is grater
Hybrid Track Angle True	0.5 deg	Accuracy specified for Ground speed > 60 kts
Hybrid Track Angle MAG	3 deg	Accuracy specified for Ground speed > 60 kts, Accuracy depending on MagVar model
Hybrid Track Angle Rate	0.25 deg/s	
Hybrid Wind Speed	5 kts	(2)
Hybrid Wind Direction	10 deg	(2) Accuracy specified for wind speed > 10 kts
Hybrid Drift Angle	1 deg	Accuracy specified for Ground speed > 60 kts
Hybrid Vertical Velocity	50 ft/min	
Hybrid Altitude	80 ft	
Hybrid Potential Vertical Speed	50 ft/min	

Table 2-13 Hybrid Navigation Accuracy

1) Not valid for LCR-100 with P/N 145130-1002 and -1005
2) No error assumed in DADS TAS input and bank angle <35 deg.

6.8 Hybrid Navigation after loss of GNSS augmentation (Coasting Operation)

NOTE

This paragraph is only applicable for the LCR-100 with P/N 145130-3000.

After loss of GNSS augmentation the AHRU provides the position drifts shown in Table 2-14 and Table 2-15.

The coasting performance after 60 minutes GNSS of augmentation in straight and level flight profile according DO-316 Appendix R is shown in the table below.

Position Drift after GNSS loss (Coasting Operation)	0.1 nm	0.3 nm	0.5 nm	1 nm	2 nm	4 nm
Time 95%	3 min	6 min	8 min	12 min	17 min	30 min

Table 2-14 Position drift after GNSS loss according DO-316

The following table shows the coasting performance after 30 minutes of GNSS augmentation including dynamic aircraft operation (taxi, curve flight,…) in order to estimate the deterministic inertial sensor errors.

Position Drift after GNSS loss (Coasting Operation)	0.1 nm	0.3 nm	0.5 nm	1 nm	2 nm	4 nm
Time 95%	10 min	17 min	20 min	28 min	40 min	60 min

Table 2-15 Position drift after GNSS loss after dynamic operation

The available coasting performance during operation is indicated on the ARINC output Label 265 Predicted HFOM (Note: The HFOM is predicted for flight phases with low acceleration (e.g. landing approach))

This value represents the 95% of the hybrid navigation position error after 10 minutes if GNSS augmentation would be lost at this moment.

7 Operating Limitations

7.1 Angular Rates and Body Accelerations

The measurement range of the system is limited:

- to ± 600 deg/s for angular rates and
- to ± 10 g for body accelerations.

If these limits are exceeded, the system may lose its reference and sets system warn annunciations. Recovery is only possible by system power off and on.

7.2 Latitude Limitations for Heading

7.2.1 AHRS Operation

Due to the high inclination of the magnetic field in the vicinity of the magnetic poles, the horizontal magnetic field strength is drastically reduced and the magnetic heading sensing will become unreliable.

The system checks the magnitude of the incoming signal. If a MSU is available and MAG mode is selected, the system operates in MAG mode independent on the horizontal magnetic field strength. If the MSU signal decreases to values where the specified accuracies cannot be guaranteed, the magnetic field strength status bit in ARINC 429 Label 271 (refer to Table 1-59) is set.

Due to variations of the signal magnitude of the individual MSUs, the exact value of the horizontal field strength leading to a low field strength indication cannot be specified. In areas where the horizontal field strength is less than 10.000 nT (refer to the map in the corresponding pilot's guide) or if low magnetic field strength is detected by the system, DG Mode operation (decoupling of the MSU) is recommended. The DG mode has to be selected manually by the pilot. If the DG mode is selected, the setting of the low field strength status is suppressed.

If the system is operated at latitudes beyond ± 80°, the heading accuracy might be degraded, also in DG mode.

7.2.2 IRS Operation in Navigation Mode

Only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000).

If the aircraft position is within the regions defined in Table 2-16, all data that are referenced to magnetic north are set to no computed data (NCD). The heading accuracies depending on latitude are defined in Table 2-9.

Region	Latitude	Longitude
Southern Hemisphere	> 82°	E180° - W180°
	> 59.5°	E118.5° - E160°
Northern Hemisphere	> 82°	0° - 360°
	> 70°	W80° - W135°

Table 2-16 Northern and Southern Magnetic Variation Cutouts

7.3 Limitations on Aerobatic Flights and Continuous Turns

7.3.1 AHRS operation

During aerobatic flight profiles (continuous maneuvering without straight and level flight condition) the platform heading and, in Basic Attitude Mode also the platform attitude, are in free inertial operation influencing the system's heading and possibly attitude accuracy due to the gyro drift. To avoid apparent gravity effects which can occur in Basic Attitude Mode, it is recommended to operate the system in Normal Attitude mode.

To maintain the specified system accuracy of the system in AHRS operation, it is necessary to fly the aircraft straight and level as defined in section 2, paragraph 6.1, in each case for a period of 60 seconds after a maximum of 20 minutes of aerobatic flight or continuous turns.

7.3.2 IRS operation in Navigation Mode

Only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000).

The specified system accuracies in the navigation mode (refer to section 2, paragraph 6) are applicable for standard applications and flight profiles. For applications with aerobatic flight profiles and continuous turns, a special investigation an evaluation of the flight profiles with their impact to the system accuracy has to be performed.

7.4 Velocity Limitation

The system is designed to meet all specified values in the subsonic velocity range. If the velocity limit is exceeded, the system accuracy may degrade.

7.5 Limitations for Gyrocompassing

This paragraph is only applicable for Gyrocompass AHRS systems (LCR-100 P/N 145130-1xxx, -2xxx and -3000).

Operational Condition for Gyrocompassing	Valid for 145130	System Behaviour
Excessive Motion > 0.2 m/s; or position change > 1 m	-1xxx, -2xxx, -3000	Gyrocompassing aborted
In Flight Alignment		No gyrocompassing, only Attitude mode possible
On ship		No gyrocompassing, only Attitude mode possible

Table 2-17 Limitations for Gyrocompassing

7.6 Limitations for Vertical Navigation

The altitude range for the vertical navigation is limited from -1000 feet to +50000 feet according ARINC 706-4.

8 Environmental Specifications according RTCA DO160-E

SECT.	SPECIFICATION	CAT.	DESCRIPTION
4	Temperature/Altitude	A2, F2	Refer to Table 2-20 and to Note (1), 55,000 feet
4.5.5	In Flight Loss of Cooling		No special cooling required
5	Temperature Variation	B	Refer to Table 2-20
6	Humidity	B	0 to 95 %, 65°C to 38°C, 10 days
7	Shock	E	Operational 6 g, 20 ms, 3 axes Crash (impulse) 20 g, 20 ms, 3 axes Crash (sustained) 20 g, 3 s, 3 axes
8	Standard Sinusoidal Vibration	SM	1.5 g
	High Level Short Duration Sinusoidal Vibration	HR	2.5 g; not certified with LCR-92/93 standard-trays P/N: 124260-0000 and 140691-0000
	Standard Random Vibration	Refer to Table 2-21	
	Robust Random Vibration	RC1	5.8 g_{rms}; non operating
	Helicopter: Sine on Random	UG	not certified with LCR-92/93 standard trays P/N: 124260-0000 and 140691-0000
9	Explosion proofness	E	
10	Waterproofness	W	
11	Fluids susceptibility	X	N/A
12	Sand and dust	D	
13	Fungus resistance	F	
14	Salt spray	S	
15	Magnetic effect	Z	
16	Power input	Z	Notes with subject to Power Interrupts: Ref. to sect. 2, Para. 9
17	Voltage spike	A	
18	AF conducted susceptibility	Z	
19	Induced signal susceptibility	ZC	
20	RF susceptibility	KG	P/N: 145130-1xxx, -2xxx and -3000
		GK	P/N: 145130-1xxx, -3000 in AHRS mode only, (2) P/N: 145130-6xxx (2)
		YY, KK	P/N: 145130-1xxx, -2xxx and -3000 in AHRS mode only P/N: 145130-6xxx and -7xxx
21	Emission of RF energy	M	
22	Lightning induced transient suscep.	A4J44	
23	Lightning Direct Effects	X	N/A
24	Icing	X	N/A
25	Electrostatic Discharge	A	
26	Fire, Flammability	C	Flammability

Table 2-18 Environmental Requirements according RTCA DO160-E

Note (1):

The LCR-100 can be operated for short time (up to 30 minutes) in the over temperature range up to +75 °C. The specified system accuracy is not guaranteed in the over temperature range.

Important condition:

After the unit was powered ON in the over temperature range the LCR-100 must not be switched off before the environmental temperature has reached the specified normal operating temperature range (-55°C - +70°C). It must be ensured that the temperature of the housing does not exceed +85°C otherwise system hardware may be damaged.

Note (2):

Additionally for digital system version (no synchro interface module, P/N: 145130-1xxx, -3000, -6xxx) the following HIRF conditions are fulfilled:

Frequency	Electric Field PM (V/m)	Pulse Width	Pulse Repetition Frequency
100 - 110 MHz	500	4 µs	1 kHz
110 - 140 MHz	100	4 µs	1 kHz
140 - 700 MHz	500	4 µs	1 kHz
700 - 900 MHz	700	4 µs	1 kHz
900 MHz - 1 GHz	700	3 µs	1 kHz
1 - 4 GHz	3000	1 µs	1 kHz
4 - 6 GHz	3600	1 µs	1 kHz
6 - 8 GHz	1500	1 µs	1 kHz
8 - 12 GHz	2500	1 µs	1 kHz
12 - 18 GHz	1200	1 µs	1 kHz

Table 2-19 Peak levels for modulation according to Category K

Operating Temp.	Temperature Variation	Operating Mode	Functionality	Valid for P/N 145130-
-40°C to +55°C	< 2°C/min	Gyro Compassing	Heading Alignment	1XXX, 2XXX, 3000
-40°C to +55°C	< 2°C/min	Navigation Mode	Position Drift 12nm/h	1XXX, 2XXX, 3000
-40°C to +55°C	< 5°C/min	Navigation Mode	Attitude and Heading	1XXX, 2XXX
-40°C to +55°C	< 2°C/min	Navigation Mode	Position Drift 2nm / 15min	3000
-55°C to +70°C	< 5°C/min	Attitude Mode	Attitude	All Versions

Table 2-20 Temperature and Temperature Variation Limitations for different modes and P/Ns

Standard Random Vibration			Operating Mode	Functionality	Valid for P/N 145130-
Cat.	**Vib.-Level**	**Spectrum**			
B2	0.74 g_{rms}	according DO-160E	Gyro Com-passing	Heading Alignment	1XXX, 2XXX, 3000
B2	0.74 g_{rms}	according DO-160E	Navigation Mode	Position Drift 12nm/h	1XXX, 2XXX, 3000
B2mod	2.00 g_{rms}	0.0032 g2/Hz @ 10 Hz – 980 Hz 0.000085 g2/Hz @ 2000 Hz	Navigation Mode	Attitude and Heading	1XXX, 2XXX
B2mod2	2.30 g_{rms}	0.0032 g^2/Hz @ 10 Hz – 1525 Hz 0.00016 g^2/Hz @ 2025 Hz	Navigation Mode	Attitude and Heading	3000
B2mod2 - 3dB	1.59 g_{rms}	0.0015 g^2/Hz @ 10 Hz – 1525 Hz 0.00010 g^2/Hz @ 2025 Hz	Navigation Mode	Position Drift 2nm / 15min	3000
C	4.12 g_{rms}	according DO-160E	Attitude Mode	Attitude	All P/N

Table 2-21 Standard Random Vibration Limitations for different modes and PNs

9 Power Interrupts

9.1 General

The AHRU operates during undervoltage conditions down to 15 VDC without any loss of performance. The AHRU shall not be operated within undervoltage conditions for longer periods.

9.2 Short Power Interrupt

Duration: between 50 and 500 ms

Power interrupts with a duration of less than 50 milliseconds are buffered by the AHRU power supply and do not influence the AHRU performance.

During power interrupts of more than 50 milliseconds, or if the input voltage drops below a threshold of 15 VDC, the AHRU switches off.

Once the power returns and the input voltage increases above an 18 VDC threshold, the AHRU automatically switches on again. Power interruptions with a duration of less than 500 milliseconds are identified as Short power interrupts, which may cause a fast realignment cycle (refer to section 2, paragraph 5.3.6), i.e.

- Mode is initiated by the Startup mode.
- In fast alignment, attitude and heading will be realigned with the propagated Euler angles based on the average aircraft motion.
- The fast alignment will be completed within 100 milliseconds, with the exception of the accelerometer derived data. This data is valid again within 1.0 second.
- When the alignment is completed, the AHRS Operational Mode is activated.

9.3 Long Power Interrupt

Duration: more than 500 ms

System response: Normal turn-on sequence (refer to section 2, paragraph 5.2 and 5.3), initiated with complete realignment.

SECTION 3

INITIAL INSTALLATION & TESTING & TROUBLESHOOTING

1 Maintenance

The statements in this paragraph refer to the AHRS system described in this manual consisting of:

- Attitude heading reference unit (AHRU)
- Installation data module (IDM)
- Mounting tray
- MSU

1.1 Scheduled maintenance

The AHRS is a commercial off the shelf (COTS) product and requires no scheduled maintenance. No preventive actions required.

1.2 Unscheduled maintenance / maintenance concept

The maintenance concept of the LCR-100 is an "O"-level maintenance concept: repair by replacement of defective LRU by purchaser, customer or user-personnel. Therefore this manual provides detailed description, operation, removal/installation, BITE and trouble-shooting procedures.

LRU repair is done by the manufacturer NG LITEF or one of its certified repair stations.

Replacement of AHRU is described in sect. 4, packaging and transportation tasks in sect. 5.

Send the defective LRU for repair to one of the following addresses:

Manufacturer:

Northrop Grumman LITEF GmbH
Customer Service
Commercial Avionics
Loerracher Str. 18
79115 FREIBURG, Germany
Phone: +49 761 4901 142
Fax: +49 761 4901 773
Email: ahrs.support@ng-litef.de

Certified repair station of manufacturer

MASCO Service Corporation

850 S. Dooley St.
Grapevine, TX 76051
U.S.A.
phone: +1 817 481 8205
fax: +1 817 488 8918
email: kayehutchison@mascoservice.com

2 NG LITEF L1MS Maintenance Set

The L1MS is a tool to set configuration parameters, to perform monitoring and storage of operational data, diagnostics for trouble shooting and to provide software updating. It can be used in the aircraft or on the bench by the customer, OEM or field service personnel.

The L1MS consists of a test box and software running on a PC (preferable a Laptop) under Windows, and a cable set.

To operate the L1MS a Windows compatible PC with a standard USB and ethernet interface is required.

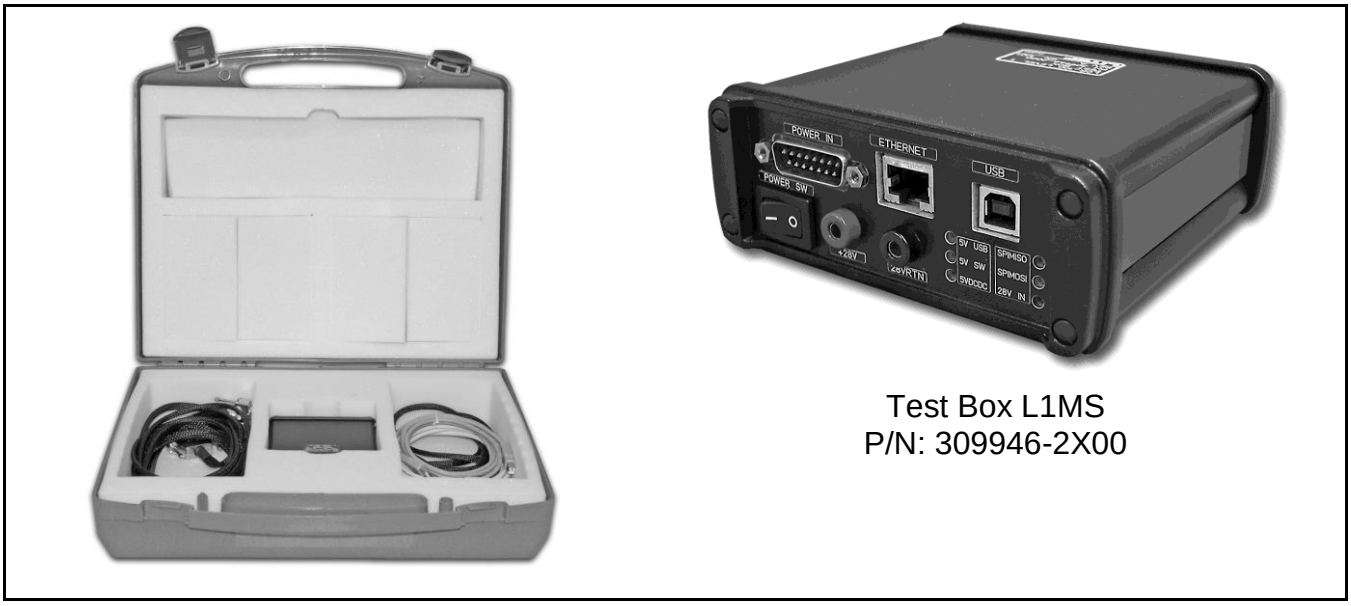
The Test Set supports the following functions for LCR-100:

- Installation support to determine mounting misalignments
- Programming and verifying of installation data
  - Mounting correction angles
  - GNSS antenna lever arms
  - Lever arms to A/C Center of Gravity
  - MSU calibration data (if applicable)
  - Upgrading IDM data (P/N 124282-0000 to -2xxx onwards)
  - Factory Reset an IDM (fills with default data)
- Diagnostics and test
  - Data Monitoring
  - Configuration of Ethernet test interface
  - Read BIT History
  - Clear BIT History (special function)
  - Read Elapsed Time Indicator

2.1 L1MS ITEM LIST

The primary component of the L1MS is a test-box which provides the operator with all the necessary connections to power the LCR-100 and establish a data transfer and access the various maintenance modes.

Figure 3-1 shows the L1MS Base version (P/N: 309946-0000 or 309946-0100). Table 3-1 gives an overview of the several L1MS versions with references, where you can find detailed parts lists and connecting diagrams.



Test Box L1MS
P/N: 309946-2X00

Figure 3-1 L1MS Base Version

Overview L1MS-Versions:

L1MS Version	To be used for	Refer to
L1MS Base Version P/N: 309946-0000 P/N: 309946-0100	All LCR-100 P/Ns to determine Pitch & Roll Compensation data	Para. 2.1.1 & Figure 3-1
L1MS Base Version with GC Tool Option P/N: 309946-0500 P/N: 309946-0501	All LCR-100 P/Ns to determine Pitch & Roll Compensation data and for: LCR-100 Gyrocompass AHRS LCR-100; P/N145130-1xxx, -2xxx and -3000: to determine Pitch, Roll & Heading compensation data	Para. 2.1.2
Commercial Parts	all L1MS versions	para. 2.1.3

Table 3-1 Overview L1MS Versions

2.1.1 L1MS Base Version

The L1MS Base Version is the basic component of all L1MS-Versions listed in Table 3-1. The L1MS Base Version can be used for all LCR-100 AHRS to determine Pitch & Roll Compensation data.

Table 3-2 shows the Parts List of L1MS base Version.

Figure 3-2 and Figure 3-3 shows 2 possible variants of connecting LCR-100 and L1MS.

P/N L1MS Base Version	**Parts List of L1MS Base Version (refer also to Figure 3-1)**	
LCR-100 L1MS 309946-0000 (Case with L1MS Test Box, Software and Cables: Details: refer to Parts List on the side)	309946-5000	LCR-100 L1MS Software Disk
	309946-2000	LCR-100 L1MS Test Box
	309946-3001	LCR-100 L1MS Cable PW OUT (J1)
	309946-3002	LCR-100 L1MS Cable SIG (J6)
	309946-3003	LCR-100 L1MS Cable Power In
	450910-8005-000	Ethernet Patch Cable (2m)
	450910-9707-000	USB Cable (2m)
	450911-1437-000	Transport Case (refer to Figure 3-1, left)
LCR L1MS 309946-0100 (Case with L1MS Test Box, Software and Cables: Details: refer to Parts List on the side)	309946-5000	LCR-100 L1MS Software Disk
	309946-2100	LCR-100 L1MS Test Box
	309946-3001	LCR-100 L1MS Cable PW OUT (J1)
	309946-3004	LCR-100 L1MS Cable SIG (J6)
	309946-3003	LCR-100 L1MS Cable Power In
	450910-8005-000	Ethernet Patch Cable (2m)
	450910-9707-000	USB Cable (2m)
	450911-1437-000	Transport Case (refer to Figure 3-1, left)

Table 3-2 Parts List L1MS Base Version

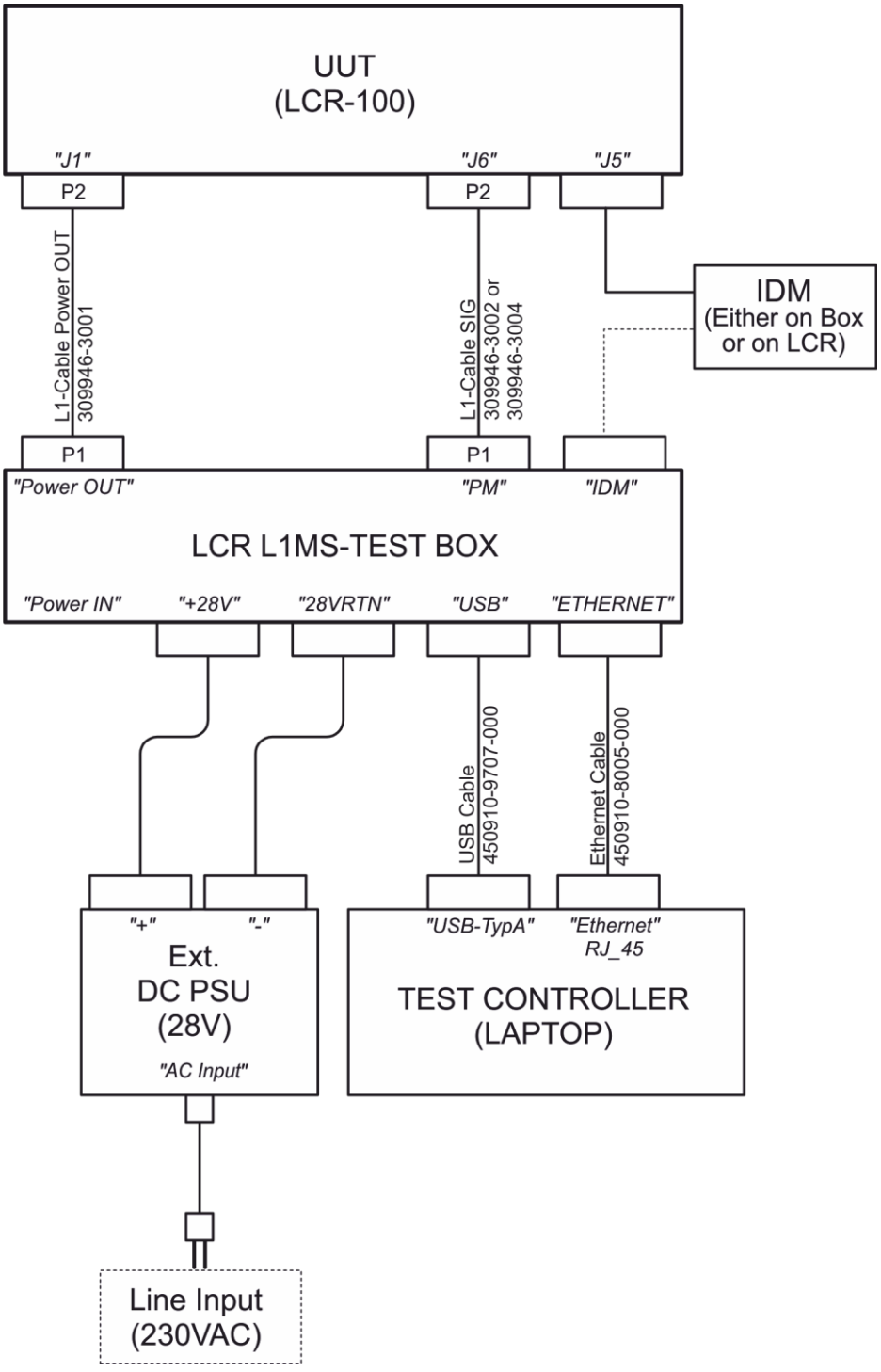


Figure 3-2 Connecting Variant 1: LCR UUT with L1MS Base Version

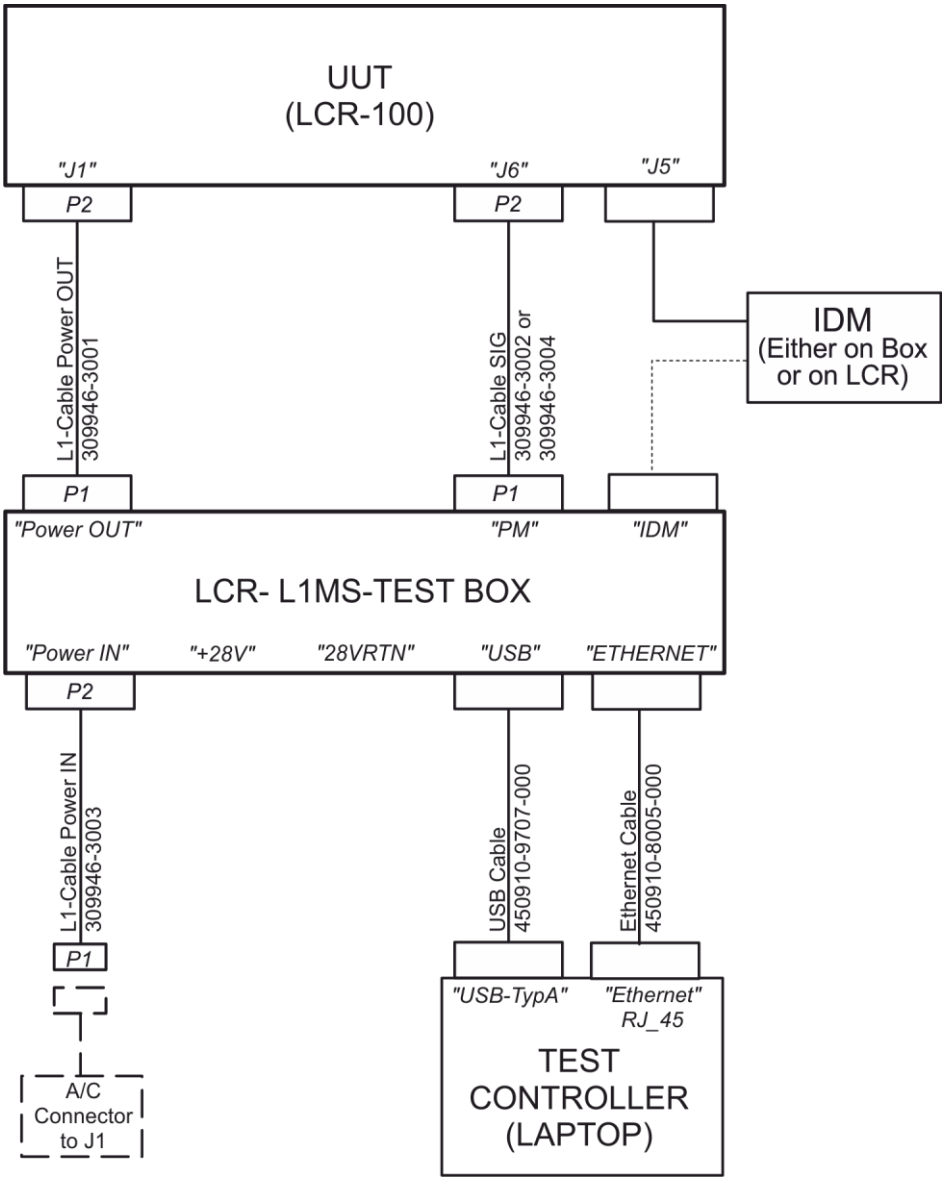


Figure 3-3 Connecting Variant 2: LCR-100 UUT with L1MS Base Version

2.1.2 L1MS Base Version with GC Tool Option

The L1MS Base Version is used for all LCR-100 AHRS to determine Pitch & Roll compensation data or - using additional the GC Tool Option - for LCR-100 Gyrocompass AHRS (P/N 145130-1xxx, -2xxx & -3000) to determine Pitch, Roll and Heading compensation data.

NOTE

The L1MS Base versions (P/N 309946-0000 or 309946-0100) as described in para. 2.1.1 is included in L1MS Base Version with GC Tool Option!

P/N L1MS Base Version with GC-Tool Option	Parts List	
309946-0500	309946-0000	L1MS Base version (parts list: Table 3-2)
	309946-0010	L1MS GC Tool Option: (parts list: Table 3-4)
309946-0501	309946-0100	L1MS Base version: (parts list: Table 3-2)
	309946-0010	L1MS GC Tool Option: (parts list: Table 3-4)

Table 3-3 Parts List L1MS Base Version with GC-Tool Option

P/N L1MS GC-Tool Option	Parts List of L1MS GC-Tool Option (refer also to Figure 3-7)	
309946-0010	310260-0000	Adapter Tray (refer to Figure 3-4)
	309946-3010	J1 Extension Cable for Power Interface (1)
	309946-3011	J6 Extension Cable and L1MS-Interface
	309946-3012	J5 Extension Cable for IDM
	309946-3016	J4 Extension Cable and ARINC-Interface

Table 3-4 Parts List L1MS GC Tool Option

1) J1 extension cable can be used to extend the cable 309946-3001 (L1-Cable Power out). In the most cases 309946-3001 is long enough and the extension cable is not required.

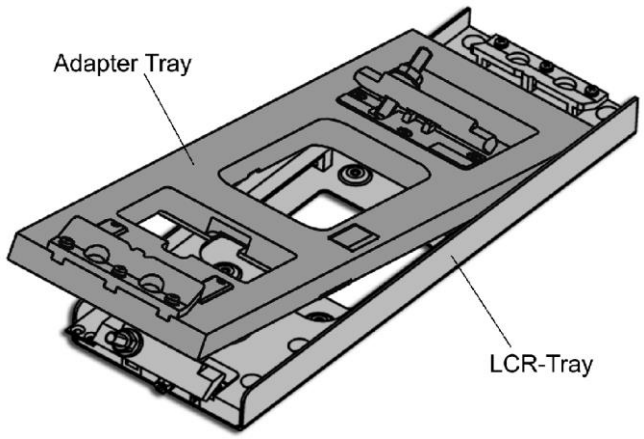


Figure 3-4 Adapter Tray LCR-100

During determination of the heading compensation data (only possible with LCR-100 Gyrocompass AHRS P/N 145130-1xxx, -2xxx and -3000) it is necessary to turn the AHRU 180 deg.

Therefore the Adapter Tray is required.

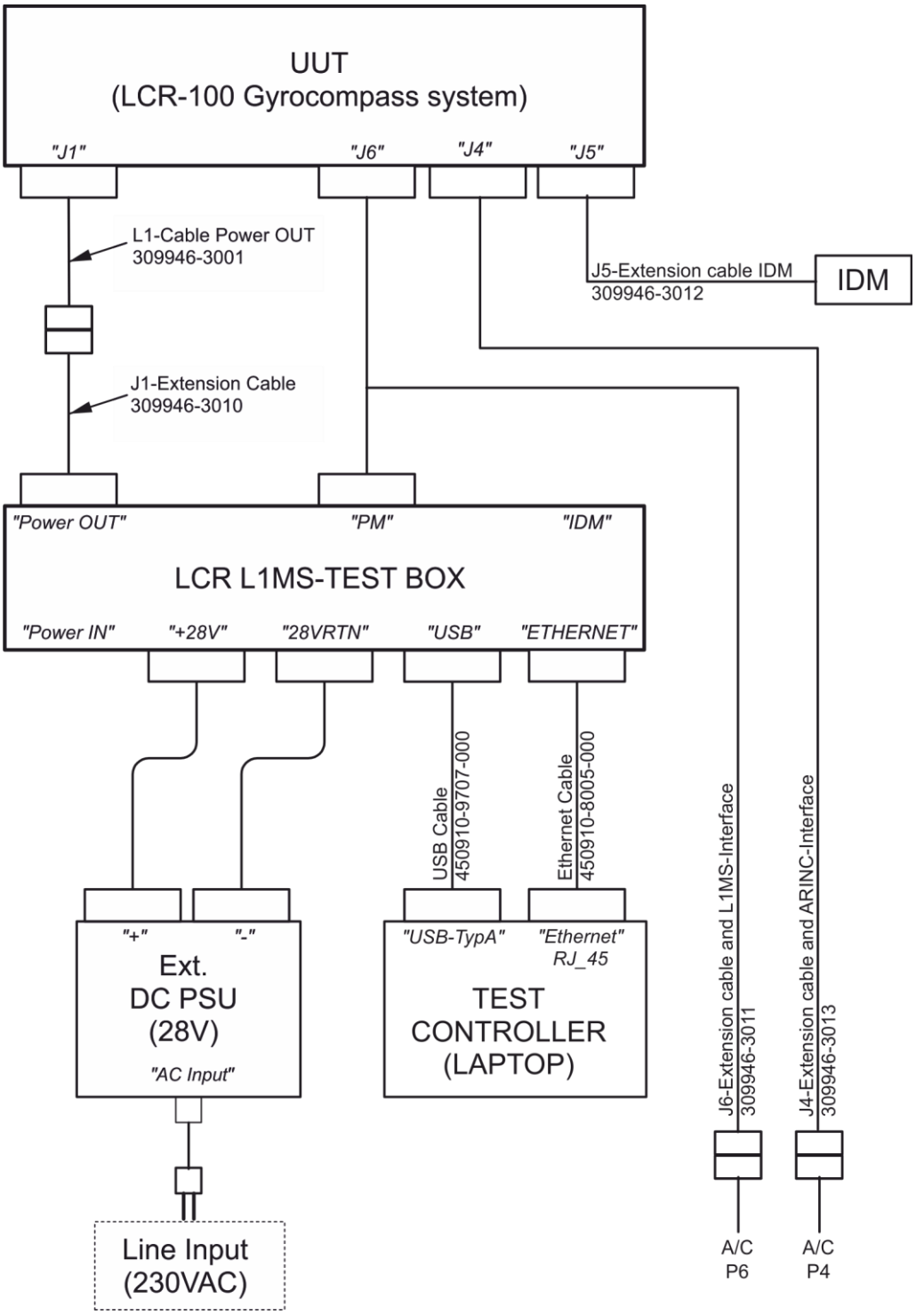


Figure 3-5 Connecting Variant 1: LCR-100 Gyrocompass AHRS with L1MS

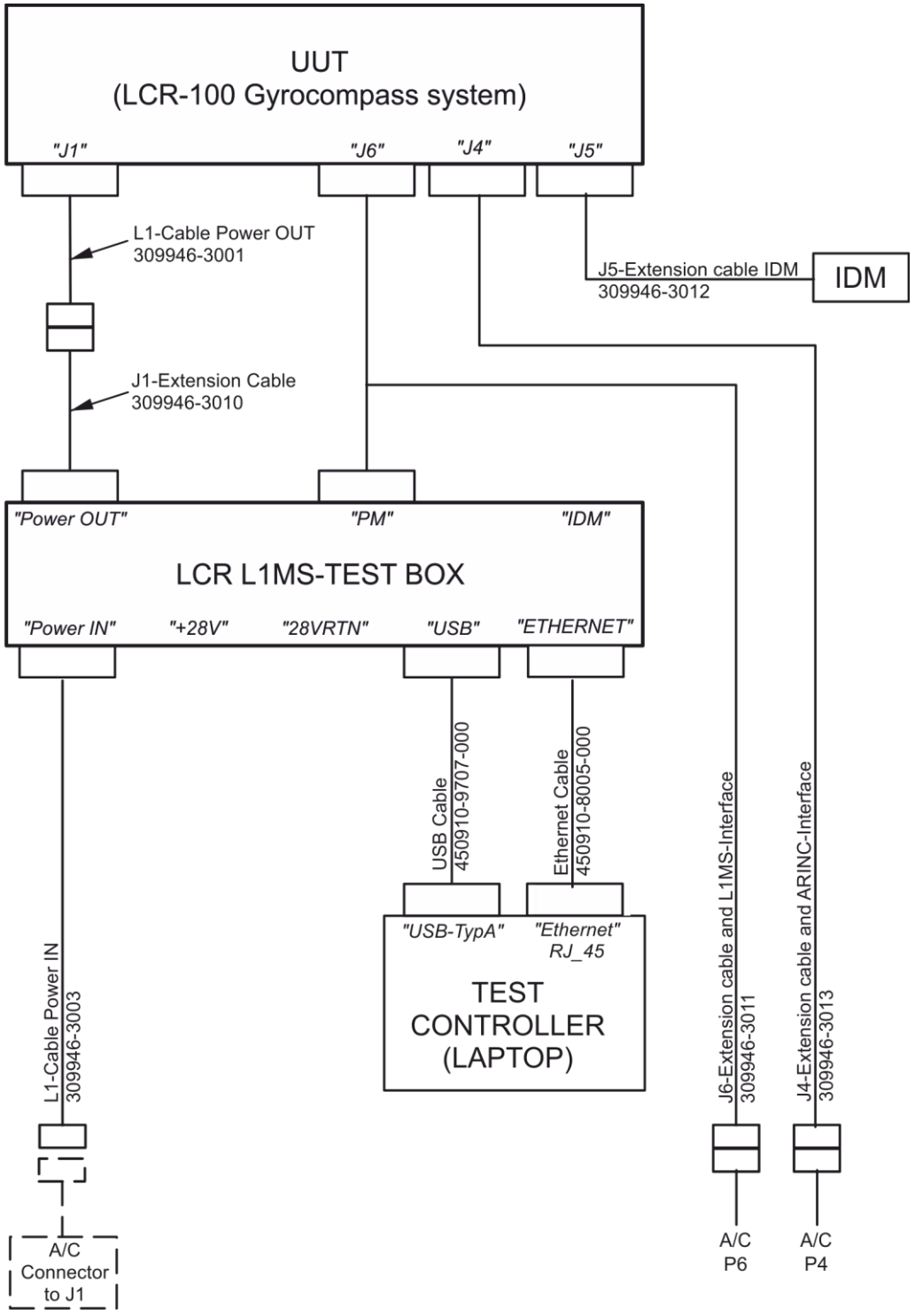
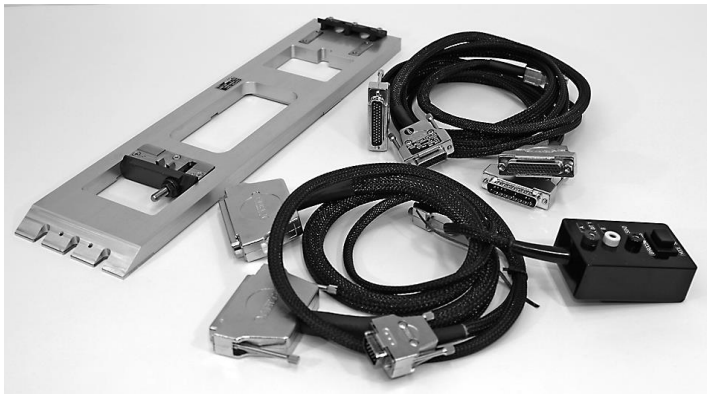


Figure 3-6 Connecting Variant 2: LCR-100 Gyrocompass AHRS with L1MS

Case with L1MS Base Version and GC Tool Option



Components of GC Tool Option

Figure 3-7 L1MS GC-Tool Option

2.1.3 Commercial Parts

1 PC with the following requirements:

- Operating System: Windows XP with Service Pack 3 or Windows 7 (32 or 64 bit Version) or Windows 8 (32 or 64 bit version)
- The minimum hardware requirements result from the used operating system.
- For the L1MS Software approximately 2 GB available hard disk space is needed.
- Software: Adobe Reader (Acrobat 6 or higher) or equivalent PDF-Reader
- 1 unused USB 2.0 data port (Supported by all above listed operating systems) or
  1 unused USB 3.0 data port (Supported by Windows 8, 32- or 64 bit version)
- 1 CD-ROM drive
- 10/1000 Ethernet Port available for Data Storage

2.2 L1MS Software overview

Table 3-5 gives an overview of the L1MS software versions. The current SW versions and Configuration Plug-In Versions are given in the Main Window that appears after start of the L1MS Software on a PC.

L1MS SW Version	Configuration Plug In Version	Description / Remarks	User Manual 309946-0000-840 Revision
309946-1000-882	No Plug-In	Initial Release	Rev. B
309946-1100-882	No Plug-In	Corrections and Enhancements	Rev. B
309946-1200-882	No Plug-In	Corrections and Lever arms to CoG	Rev. C
309946-1210-882	No Plug-In	Corrections	Rev. C
309946-1300-882	309946-1301-881	New Graphical User Interface	Rev. E
309946-1400-882 (includes Configu-ration Plug-In 309946-1401-881)	309946-1402-881	LCR-100 MOD 26 added	Rev. E
	309946-1403-881	New LCR-100 P/N added: - 145130-1006 MOD 26	
	309946-1404-881	New LCR-100 P/N added: - 145130-1006 MOD 27 - 145130-2010 MOD 19,20,25,26 - 145130-2011 MOD 26 - 145130-7010 MOD16,18,20,25,26 - 145130-7011 MOD 25,26 - 145130-7110 MOD 18,20,25,26	
	309946-1405-881	Corrections (MagVar Model CRC)	

Table 3-5 Overview L1MS Software Versions

2.3 Applicable Documents for L1MS

The User Manual (P/N: 309946-0000-840) for L1MS is included on the Software Disk (located in the CD's "root directory".) that is part of the L1MS Base Version.

An electronic version of this manual in PDF format can be run from the software via the help function.

3 AHRU Alignment Requirements

3.1 Installation of Mounting Tray

NOTE

All technical data concerning accuracy of LCR-100 Gyrocompass AHRS mentioned in this manual refer to an original LCR-100 type Mounting Tray (P/N 145137-0100 or 145138-0100). Operation in Navigation Mode is only certified for these trays.

The LCR-92/93 Mounting Tray (standard: P/N 124260-0000 or 140691-0000, ruggedized: P/N 144200-0000 or 144201-0000) can also be used for LCR-100 (concerning the outlines).

With an LCR-92/93 type Mounting Tray (standard or ruggedized version) Northrop Grumman LITEF GmbH does not guarantee the specified accuracy for the Gyrocompass AHRS (LCR-100 P/N 145130-1xxx, -2xxx and -3000) will be achieved.

The specified accuracy for the Standard AHRS LCR-100 system (P/N 145130-6xxx and -7xxx) does not depend on the Mounting Tray used.

NOTE

Installation of the LCR-100 Mounting Tray for use with Gyrocompass AHRS:

The mounting tray is to be installed and grounded according to the outline drawings (refer to Figure 1-14 and Figure 1-15) (use the four mandatory fixing holes and the grounding screw). The six other holes can additionally be used. If the Tray is not mounted as required in the outline drawing Northrop Grumman LITEF GmbH does not guarantee the specified accuracy for the Gyrocompass AHRS will be achieved.

Installation of the LCR-100 Mounting Tray for use with Standard AHRS:

For a standard AHRS you have to install the Mounting Tray at 4 fixing holes, too. However, it is recommended to use at least two of the four fixing holes at the front of the Tray and two of the four fixing holes at the rear of the Tray.

The outline drawings of the mounting trays with and without fan are shown in Figure 1-14 through Figure 1-19. Figure 3-8 shows the principle mounting of the AHRU on the Mounting Tray. Figure 1-4 shows the four possible mounting positions of the AHRU that are defined by the Mounting Position Discretes (refer to Table 1-17).

The orthogonal alignment of the Mounting Tray with respect to the pitch, roll and azimuth axes of the aircraft is fundamental for the operation of the AHRS. Therefore, the AHRU Mounting Tray, for hard-mount as well as palletized installation, must be aligned as accurately as possible/necessary to the aircraft axes. For mounting tolerances and Tray Alignment Procedure refer to paragraph 3.2.

3.1.1 Mounting and Base-Plate Recommendations

The typical mounting of avionics equipment on shelves of a rack is usually adequate for electronic boxes, but is not satisfactory for motion sensing systems like the LCR-100. Metal shelves equipped without any stiffening devices are too weak for mounting inertial systems.

The main consideration in the installation of any inertial System is to avoid angular vibration at the system mounting interface.

Examples of means for avoidance or reduction of angular vibration are:

- Minimization of outline of the mounting base: no large plates or sheets should be used as base for the tray, in order to avoid large deflections and bending during vibration.
- Mounting location of tray in the center of the supporting structure:
  any offset of the mounting location from the center of a vibrating structure transforms the longitudinal deflection into an angular movement, which has to be avoided.
- Increasing stiffness of the mounting base; this has to be of major concern:
  to avoid angular movement of the tray and the system the mounting base has to be stiffened by means of additional stiffeners running in both horizontal directions (e.g. U-shaped sheet metal rods, riveted to the base plate).

Experience shows that honeycomb composite materials, which are of frequent use in helicopters, have the best considerable vibration response; they combine the three major advantages:

- Lightweight
- Increased stiffness
- Intrinsic damping

Therefore those honeycomb materials should be the first choice for a mounting base plate.

Choice of LCR location within the aircraft:

The location for mounting the LCR-100 should be chosen in general with respect to minimize the vibration input to the system. The AHRU is generally located in the aircraft's equipment bay electronics rack.

3.1.2 Mounting Screws

The tray is designed for using metric M4-screws (e.g. DIN EN ISO 4762 hexagon socket or DIN EN ISO 7045 pan head) in combination with DIN 433 washers for mounting the tray onto a base. Alternatively the use of 8-32 screws (according to ANSI/ASME standard) together with NAS620 No. 8 washers is permissible (torque for both screw types 2.2 ± 0.15 Nm respectively 19.5 ± 1.5 in-lbs). The holes are large enough to allow for the heading alignment (Tray alignment procedure: refer to paragraph 3.2).

The LCR-100 Mounting Trays as well as the LCR-92/93 ruggedized Mounting Trays have to be grounded using a Grounding Screw (8-32 screw, according to ANSI/ASME standard) with tooth washer. Torque: 2.2 ±0.15 Nm respectively 19.5 ± 1.5 in-lbs.

3.2 Mounting Tolerance and Tray Alignment

3.2.1 Required accuracy for Tray Alignment

In order to ensure sufficient accuracy in the aircraft attitude and other related outputs, it is necessary that the AHRU (Tray) is installed or compensated to a remaining tolerance of at least ± 12 arcminutes (± 0.2 degrees) in azimuth, pitch and roll with reference to the principal aircraft axes.

3.2.2 Tray mounting and alignment steps

(1) Mechanical Mounting and Alignment

- Mechanical installation according paragraph: 3.1

(2) Determination of the Tray Misalignment

- Measurement of Tray Misalignment (using appropriate measurement equipment) or
- Determination of Tray Misalignment using L1MS
  - Determination of Tray Misalignment in Pitch, Roll and Yaw (Heading): refer to paragraph: 3.3.2.1 (Applicable only for LCR-100 Gyrocompass systems, P/N 145130-1xxx, -2xxx and -3000) or
  - Determination of Tray Misalignment in Pitch and Roll: refer to paragraph 3.3.2.4 (Applicable for all LCR-100 Systems)

(3) Compensation of Tray Misalignment

- Mechanical adjustment by turning and shimming the tray to achieve the required accuracy as stated in paragraph 3.2.1.
- Storing the determined compensation values into the IDM using L1MS

NOTE

The compensation values are aircraft specific. The IDM is mechanically connected with the tray. As long as the tray is mounted to the A/C the compensation values are valid for any AHRU that is mounted into this tray. The compensation values are limited to ±3 deg.

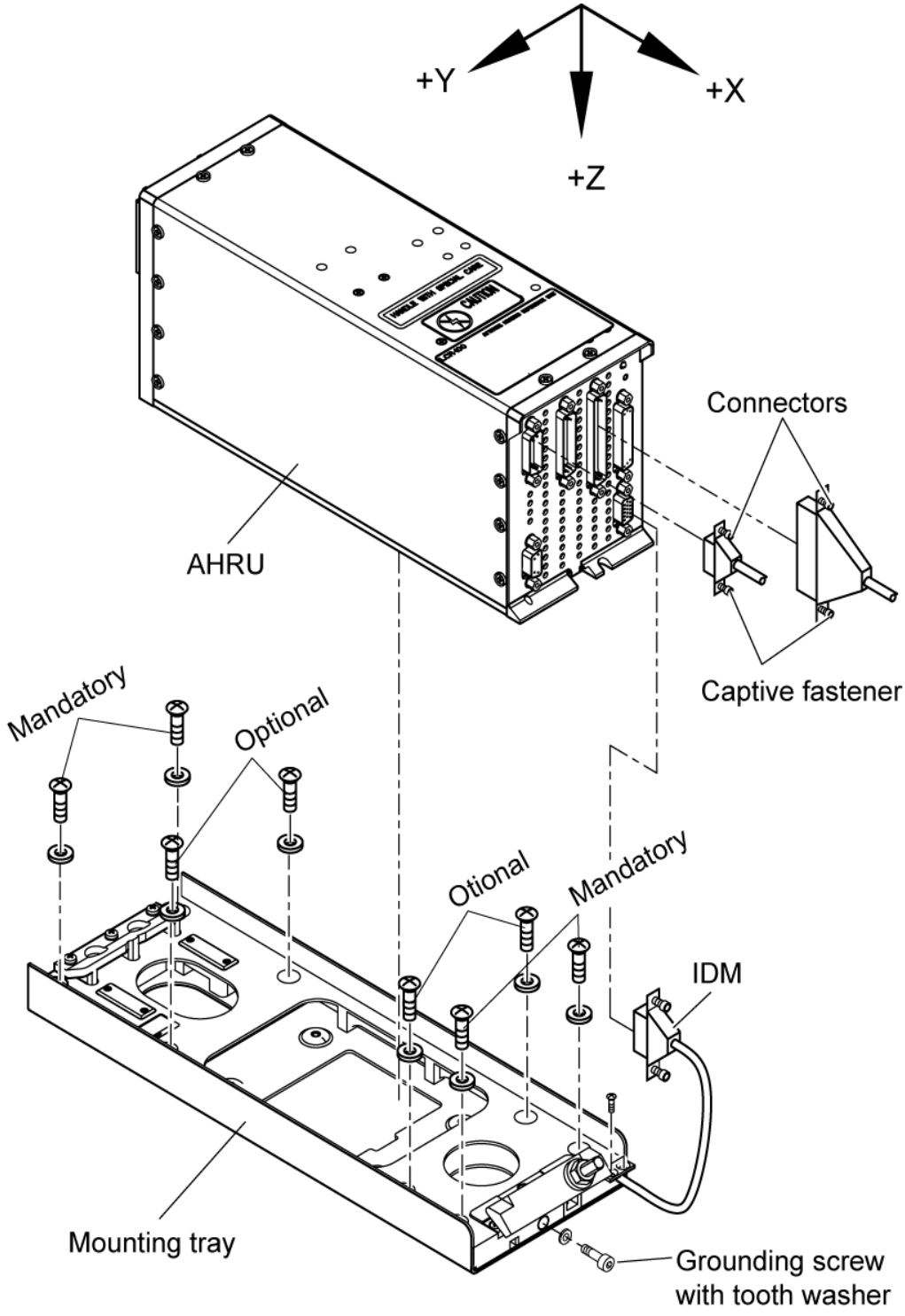


Figure 3-8 AHRU principle mounting on the Mounting Tray

3.3 Determination and Compensation of Tray Misalignment by means of the LCR-100 and the L1MS

Depending on the LCR-100 P/N there are two procedures available to determine the misalignment compensation values:

- Determination of correction values for the Roll- and Pitch-misalignment (applicable for all LCR P/Ns)
- Determination of correction values for Roll-, Pitch- and Heading-misalignment (applicable for LCR-100 Gyrocompass systems (P/N: 145130-1xxx, -2xxx and -3000))

Both procedures mentioned above can be either performed by:

- Automatic Tray Alignment Procedure (refer to paragraph 3.3.1)

Or:

- Manual Tray Alignment Procedure (refer to paragraph 3.3.2)

Paragraph 3.4 describes how to determine the GNSS Lever Arms from the AHRU to the GNSS antennas and in paragraph 3.5 the determination of the Lever Arms from the AHRU to the A/C Center of Gravity.

3.3.1 Automatic Tray Alignment Procedure

The L1MS allows a fully automatic system alignment for all LCR-AHRS. Paragraph 1, section 3 gives an overview over the several L1MS types and shows how to wire the test cables. This procedure performs both: determination and storage of the compensation data in one working step.

The Automatic Alignment procedure is described in the L1MS User Manual (refer to section 3, paragraph 2.3).

3.3.2 Manual Tray Alignment Procedure

3.3.2.1 Tray Alignment procedure to determine Tray Misalignment Compensation Values in Pitch, Roll and Yaw (Heading)

This paragraph is only applicable for LCR-100 Gyrocompass systems (P/N 145130-1xxx, -2xxx and -3000), except for P/N 145130-1002 and -1005 (With this System you can only perform the procedure described in paragraph 3.3.2.4). The required equipment L1MS Base Version with GC Tool Option is listed in Section 3, paragraph 2.1.2. Wiring of AHRU, L1MS and A/C -cables: refer to section 3, Figure 3-5.

NOTE

For multiple LCR-100 installations in one aircraft this procedure is to be repeated accordingly.

3.3.2.2 Preconditions

Working Step	Value
1 Make sure the A/C is leveled in the principle A/C axes.	____
2 Determine the surveyed actual true heading (H_A) of the A/C to an accuracy to the first decimal position ±0.05 deg.	H_A = _ _ _ . _ deg
3 Make sure that a source (CDU/FMS or GNSS) to enter geographical position via ARINC 429 input on J6 to the system is available.	____
4 Set the misalignment constants in the IDM to zero (Refer to L1MS User Manual).	____

3.3.2.3 Alignment Procedure

Working Step	Value
5 Fix the AHRU unit on the Tray. Connect it with L1MS and A/C wiring as shown in section 3, Figure 3-5.	____
6 Switch-on the AHRU and monitor the Pitch, Roll and True Heading data. Monitoring can be performed either on the ARINC 429 output or on the test output by means of the L1MS.	____
7 Enter geographical position via FMS/CDU input or via GNSS input.	____
8 Let the AHRU run for 10 minutes.	____
9 Read the Pitch (P_T) and Roll (R_T) and True Heading angle (H_{1T}) of AHRU. Round the angle to the nearest 0.1 deg value.	P_T = _ _ _. _ deg R_T = _ _ _. _ deg H_{1T} = _ _ _. _ deg
10 Wait 3 minutes. Then read again the True Heading angle and record as (H_{2T})	H_{2T} = _ _ _ . _ deg
11 While still powered, take the AHRU out of the Tray and install the Adapter Tray (refer to Figure 3-4). Turn the AHRU 180 deg and move it into the Adapter Tray. Ensure that it fits into the rails and that it does not move during test.	____
12 Let the AHRU run for 10 minutes.	____
13 Read the True Heading angle ($H_{180\text{-}1T}$) of AHRU with an accuracy to the first decimal position.	$H_{180\text{-}1T}$ = _ _ _. _ deg

Working Step	Value
14 Wait 3 min. Then read again the True Heading angle and record as ($H_{180\text{-}2T}$)	$H_{180\text{-}2T}$ = _ _ _. _ deg
15 Exit the L1MS SW. This exit will switch-off the AHRU. Then take it out of the Adapter Tray and install it back to the original tray.	____
16 Calculate the mean values of the heading measurements H_{1T} and H_{2T} also $H_{180\text{-}1T}$ and $H_{180\text{-}2T}$ $H_T = 0.5\ (H_{1T} + H_{2T})$ $H_{180T} = 0.5\ (H_{180\text{-}1T} + H_{180\text{-}2T})$	H_T = _ _ _ . _ deg H_{180T} = _ _ _ . _ deg
17 Calculate the compensation values of AHRU to be stored in the IDM. We recommend using a scientific calculator. Pitch compensation value (1) $P_{comT} = - P_T$ Roll compensation value (1) $R_{comT} = - R_T$ Heading compensation value $H_{cT\text{-}90} = - (H_T - 0.5\ (H_T - (H_{180T} - 180)) - H_A)$ $H_{comT} = H_{cT\text{-}90}$ - Cardinal angle (1) Dependent on the heading H_A of the A/C the cardinal angle (90, 180, 270, 360 deg) may have to be subtracted from the result $H_{cT\text{-}90}$ to get the Heading compensation value H_{comT} to be stored. e.g.: $H_{cT\text{-}90} = 268.7$ $H_{comT} = 268.7 - 270 = -1.3$ Accuracy required to the first decimal position.	P_{comT} = _ _ _ . _ deg R_{comT} = _ _ _ . _ deg $H_{cT\text{-}90}$ = _ _ _ . _ deg H_{comT} = _ _ _ . _ deg
18 Store the compensation values into the IDM using the L1MS page "IDM Configuration" (refer to L1MS User Manual on the software disk of the L1MS). Now the compensation procedure for AHRU is finished.	____

1) The Pitch and Roll-compensation value may not exceed a value of 3° If the compensation value exceeds 3°, the mechanical Tray alignment has to be rectified by turning and shimming the tray until the alignment tolerance is within ± 3° in azimuth, pitch and roll with reference to the principal aircraft axes..

3.3.2.4 Tray Alignment procedure to determine Tray Misalignment Compensation Values for Pitch and Roll only

This paragraph is applicable for all AHRS systems (including 145130-1002 and -1005). The required equipment L1MS Base Version is listed in Section 3, paragraph 2.1.1. Wiring of AHRU, L1MS and A/C -cables: refer to section 3, Figure 3-2.

NOTE

For multiple LCR-100 installations in one aircraft this procedure is to be re-peated accordingly

3.3.2.4.1 Preconditions

Working Step	Value
1 Make sure the A/C is leveled in the principle A/C axes.	____
2 Set the misalignment constants in the IDM to zero (Refer to L1MS User Manual).	____

3.3.2.4.2 Alignment Procedure

Working Step	Value
3 Fix the AHRU on the Tray. Connect it with L1MS and A/C wiring as shown in section 3, Figure 3-2.	____
4 Switch-on the AHRU and monitor the Pitch and Roll data. Monitoring can be performed either on the ARINC 429 output or on the test output by means of the L1MS. Let the unit run for 5 minutes.	____
5 Read the Pitch (P_T) and Roll (R_T) angle of AHRU on the L1MS page "Diagnostics" / "Data Monitoring". Round the angle to the nearest 0.1 deg.	P_T = _ _ _ . _ deg R_T = _ _ _ . _ deg
6 Calculate the compensation values of the AHRU to be stored in the IDM. Pitch compensation value (1) $P_{comT} = - P_T$ Roll compensation value (1) $R_{comT} = - R_T$ Accuracy required to the first decimal position.	P_{comT} = _ _ _ . _ deg R_{comT} = _ _ _ . _ deg

Working Step	Value
7 Store the compensation values into the IDM using the L1MS page "IDM Configuration" (refer to L1MS User Manual on the software disk of the L1MS). Now the compensation procedure for AHRU is finished.	———

1) The Pitch and Roll-compensation value may not exceed a value of 3° If the compensation value exceeds 3°, the mechanical Tray alignment has to be rectified by turning and shimming the tray until the alignment tolerance is within ± 3° in azimuth, pitch and roll with reference to the principal aircraft axes..

3.4 Determine Lever Arms from AHRU to the GNSS antennas

This paragraph describes how to determine the GNSS Lever Arms.

Definition:

Value of distance measurement: from the AHRU (Center of Gyro Measurement Axes, refer to Figure 1-8) to the GNSS antennas in the A/C with reference to the A/C Axes.
The positive direction of the A/C axes X, Y and Z are defined as shown in Figure 3-9.

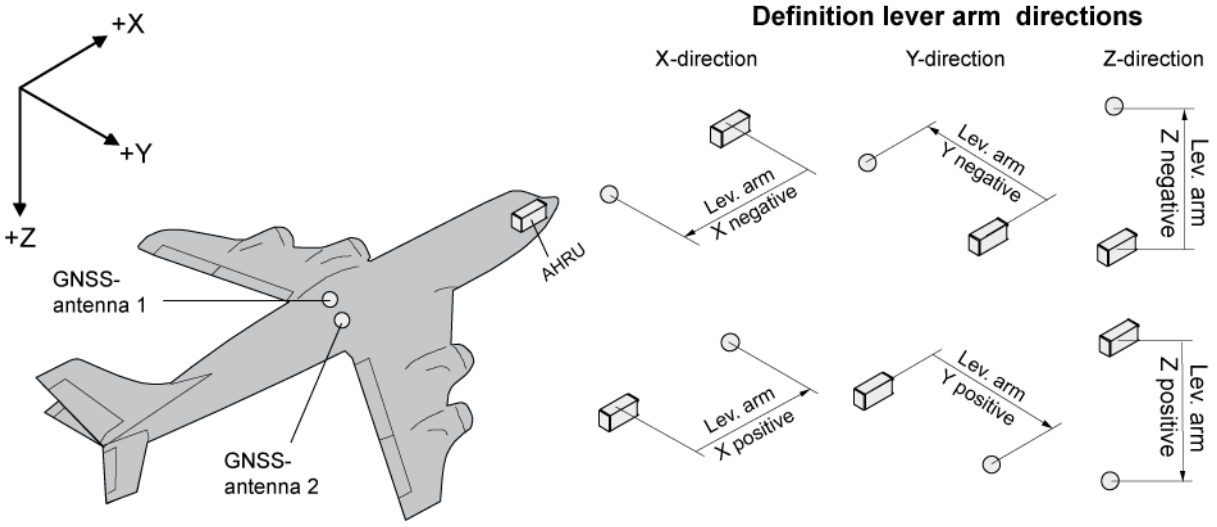


Figure 3-9 Lever Arms from AHRU to GNSS antennas (Example)

Procedure

Working Step	Value
1 Measure the distance in meters from AHRU-Center of gyro measurement axes (1) to the allocated GNSS-Antenna 1 in x, y and z direction of the A/C	$GNSS1_X$ = _ _ . _ m $GNSS1_Y$ = _ _ . _ m $GNSS1_Z$ = _ _ . _ m
2 Measure the distance in meters from AHRU-Center of gyro measurement axes (1) to the allocated GNSS-Antenna 2 in x, y and z direction of the A/C	$GNSS2_X$ = _ _ . _ m $GNSS2_Y$ = _ _ . _ m $GNSS2_Z$ = _ _ . _ m
3 Store the 3 distance values in the IDM using the L1MS (refer to L1MS User Manual)	____

1) Position of the Center of gyro measurement axes: refer to AHRU Outline drawing, Figure 1-8

3.5 Determine Lever Arms from AHRU to the A/C Center of Gravity

This paragraph describes how to determine the Lever Arms to A/C Center of Gravity

Definition:

Value of distance measurement: from the AHRU (Center of Gyro Measurement Axes, refer to Figure 1-8) to the A/C Center of Gravity with reference to the A/C Axes.
The positive direction of the A/C axes X, Y and Z are defined as shown in Figure 3-10.

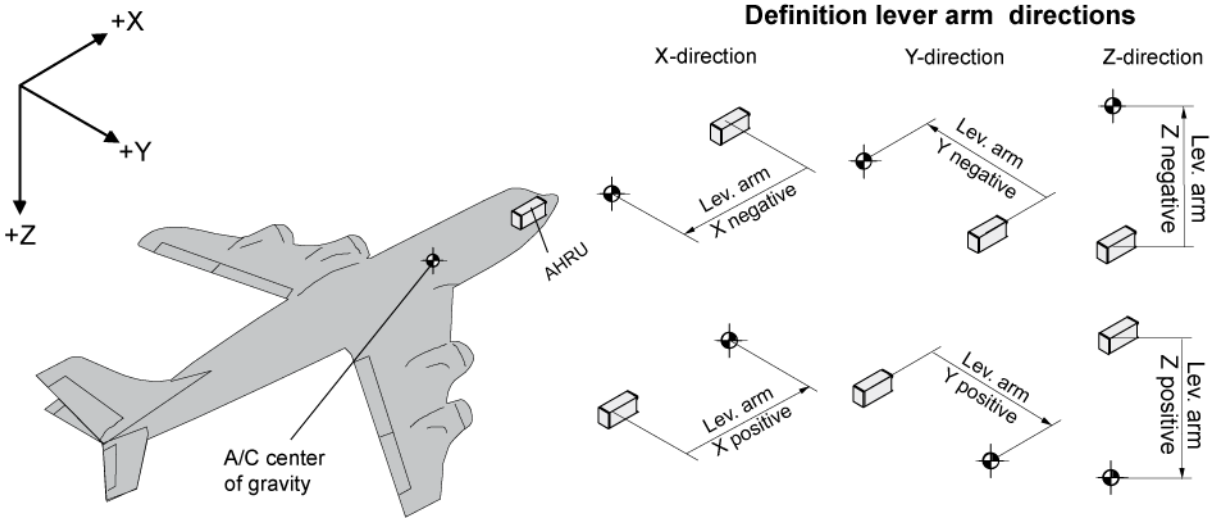


Figure 3-10 Lever Arms from AHRU to the A/C Center of Gravity (Example)

Procedure

Working Step	Value
1 Measure the distance in meters from AHRU Center of gyro measurement axes (1) to the A/C Center of Gravity in x, y and z direction.	CoG_X = _ _ _ . _ _ m CoG_Y = _ _ _ . _ _ m CoG_Z = _ _ _ . _ _ m
2 Store the 3 distance values in the IDM using the L1MS (refer to L1MS User Manual). **Note:** The storage of the CoG Lever Arms is first possible from L1MS Version 1200.	——

1) Position of the Center of gyro measurement axes: refer to AHRU Outline drawing, Figure 1-8

4 Initial Installation - general remarks

No manual testing of the AHRS is required, and troubleshooting is simplified by the built-in fault monitoring and self-test circuits of the AHRUs. When power is applied to the System, a series of self-tests are performed to verify System functions. In addition, the System contains hardware and Software monitors and performs continuous background hardware and Software verification tests. Failure of these tests results in the Output of warn Signals or System shutdown. The Maintenance Discrete Output words are shown in Table 3-7 through Table 3-10. Heading Fail, Attitude Fail, Yaw Rate Fail and Turn Rate Fail warning Signals will set flags on the aircraft flight displays. The AHRS Fail warning Signal provides a fail warning Output each time one of the basic display warnings is set. This AHRS Fail warning can be used in conjunction with the MASTER WARNING display system.

Manually initiated self-tests can also be performed on each of the individual AHRUs. Self-test discretes, one for each of the AHRUs, are provided for implementation. Actuation of the discrete causes that unit to Output test values to the aircraft Systems. The parameters Output and the associated test values are shown in section 1, paragraph 5.

The monitoring and warning criteria are stated and shown in Table 3-11. The DITS Status Information is provided in section 1, paragraph 4.3.2.1.6.

A chart of fault monitoring provisions (Maintenance Discrete Outputs - Labels 350 to 353) is included in Table 3-7 through Table 3-10.

NOTE

Paragraph 5.2 shows the check-list for the steps to be followed when a fault appears during an initial installation of a System. Likewise, the check-list may also be consulted as a fault finding guide during the time that the equipment is in Service.

4.1 Initial Installation Check

If you are working on an initial installation, the following list may help you to check the layout of your wiring. (Front view of LCR-100 with all connectors: refer to Figure 1-7.)

(4) Power Supply (J1) (Signals and Pin Assignment J1: refer to Table 1-84)

- Primary power available at J1, Pin-1/Pin-9 and J1, Pin-2/Pin-10
- If used auxiliary power at J1, Pin-3/Pin-11 and J1, Pin-4/Pin-12.
- Power to control discretes using J1, Pin-8 with J1, Pin-15 as ground reference.

(5) Fan (J2) (Signals and Pin Assignment J2: refer to Table 1-85)

- In case the AHRS is mounted on a tray with fan, the connector of the tray mounts to J2 of the AHRS. Please note that this will enable a fan test that monitors the current to the fan.

(6) Synchro I/O (J3) (Signals and Pin Assignment J3: refer to Table 1-86)

- Check if all used synchro and two wire AC outputs have their respective input (reference) voltage.
- Check if all outputs have their respective wiring.

(7) I/O (J4) (Signals and Pin Assignment J4: refer to Table 1-87)

This paragraph is only applicable if a MSU is available.

- Check the MSU (Flux Valve) connection with respect to section 1, Table 1-87 (J4, Pin-2 and -22 respectively J4, Pin-9/Pin-30/Pin-51) if applicable.
- Check for connection between J4, Pin-39 and J4, Pin-60 (mandatory) if applicable (refer to Table 1-90).
- Check the program pins to satisfy the ODD parity, refer to section 1, paragraph 4.2.1.2 and item (8) of this paragraph.
- Check used control discretes.
- Check ON GND / IN AIR (J4, Pin-37). Please note that the ON GND Status MUST be present at that time when power is applied to the AHRS.
- Check all used operational interfaces (ARINC 429).

(8) IDM (J5) (Signals and Pin Assignment J5: refer to Table 1-88)

The IDM will be mounted on J5 and stores compensation data for MSU (Flux Valve), Mounting correction and Acceleration monitor. The IDM stays with the tray (if not defective) and is therefore tied to the tray using a cord.

If power is applied to the AHRS, the AHRS should power up and indicate proper Operation (flags are out of view) after 25 seconds of alignment time. If HSI/ADI indicates incorrect operation please refer to paragraph 4.2 in this section. If the AHRS indicates proper operation, a general test shall be applied to ensure correct control of the AHRS. The next verification step would test the displays or indicators for correct display of data.

Basic tool to check out an existing installation for proper operation is an ARINC 429 reader and some kind of J4 or J6 Break-Out Cable that allows to have access to one of the six ARINC data busses coming from the AHRS. Alternatively you can follow the instructions given in the troubleshooting procedures (refer to paragraph 4.3 in this section).

(9) I/O (J6) (Signals and Pin Assignment J6: refer to Table 1-89)

- Check all used operational interfaces (ARINC 429).

(10) Verify proper AHRS Operation using Maintenance Labels

Connect ARINC 429 Reader to AHRS ARINC output and switch to read Label 350 through 353.

- All data bits should be set to '0'. If one or more bits are set to '1', please refer to paragraph 5.2 in this section.
- If all data bits are '0' but your indicator shows invalid data, the problem is in the wiring from the AHRS to the indicator.

(11) Verify Programming Discretes

Connect ARINC 429 Reader to AHRS ARINC Output and switch to read Label 303 (input discrete 1) on the ARINC reader (input discrete word 1, Label 303: refer to Table 1-69).

- Verify your installation setup as there are
- Mounting Position 1 on Bit 14 (set to one if activated)
- Mounting Position 2 on Bit 15 (set to one if activated)
- Parity on Bit 18 (set to one if activated)
- DG Mode Logic Select on Bit 19 (set to one if activated)
- Yaw/Rate SF Select 1 (1) / DADS Select 1 (2) on Bit 20 (set to one if activated)
- Yaw/Rate SF Select 2 (1) / DADS Select 2 (2) on Bit 21 (set to one if activated)
- ARINC Turn Rate Select on Bit 22 (set to one if activated)
- Ground/Air Logic Select on Bit 23 (set to one if activated)
- MSU Excitation Voltage Select on Bit 24 (set to one if activated)
- ARINC Update Rate Select on Bit 25 (set to one if activated)

1) Only for systems with AHRS and gyrocompassing functions and with Synchro Interface Module (LCR-100 P/N 145130-2xxx)

2) Only for systems with AHRS and gyrocompassing functions without Synchro Interface Module (LCR-100 P/N 145130-1xxx)

NOTE

Please check that the sum of activated inputs MUST be an ODD number. You will get non-valid indication of the HSI and ADI if the requirement is not satisfied.

(12) Verify Input Discretes

Connect ARINC 429 Reader to AHRS ARINC Output and switch to read Label 304 (input discrete 2) on the ARINC reader. The description assumes the A/C is On Ground.

Verify your installation

- Toggle the Selftest Switch in the cockpit and watch Bit 16 to toggle. Alternatively watch the ADI/HSI to indicate a + 45° Roll, + 5° pitch and + 15° Heading display. This will not work when the Ground/Air discrete input indicates "in air".
- Toggle the DG/Mag or Free/Slaved Switch in the cockpit and watch Bit 19 to toggle. Alternatively the HSI may indicate DG Mode if applicable.
- Toggle the Slew Left Switch with the DG/Mag Switch in DG Mode in the cockpit and watch Bit 21 to toggle. The HSI will decrease heading.
- Toggle the Slew Right Switch with the DG/MAG SWITCH in DG Mode in the cockpit and watch Bit 22 to toggle. The HSI will increase heading.
- Toggle the GND / In Air switch to In Air and watch Bit 23 to toggle. Alternatively you can activate the selftest with the AHRS on ground. This will cause HSI/ADI as explained before. If you set the AHRS into "In Air" mode, the selftest will be inhibited.

4.2 Initial AHRS and Indicator Checks

The proper operation of the AHRS together with the displays like HSI/ADI or MFD may be done as follows:

(1) Check HSI

- Turn A/C clockwise by more than + 5° - alternatively remove AHRU from tray (refer to Figure 3-11 - do not disconnect connectors!) and turn AHRU clockwise more than +5°. Watch HSI to respond respectively. Check out also other indicators like stormscope etc.

(2) Check ADI

- Remove AHRU from tray (refer to Figure 3-11 - do not disconnect connectors!) and hold it with its longitudinal axis parallel to the tray and rotate the AHRU to simulate pitch and roll and observe ADI. Note that the AHRU mounting position influences the ADI response as shown in Table 3-6.

AHRU rotation (Minimum value for test)	ADI response depending on mounting position (mp)			
	mp plug forward	**mp plug aft**	**mp plug right**	**mp plug left**
+ 5° pitch	A/C nose up	A/C nose down	Left wing down	Right wing down
- 5° pitch	A/C nose down	A/C nose up	Right wing down	Left wing down
+ 5° roll	Right wing down	Left wing Down	A/C nose up	A/C nose down
- 5 ° roll	Left wing down	Right wing down	A/C nose down	A/C nose up

Table 3-6 ADI response to AHRU rotation depending on mounting position

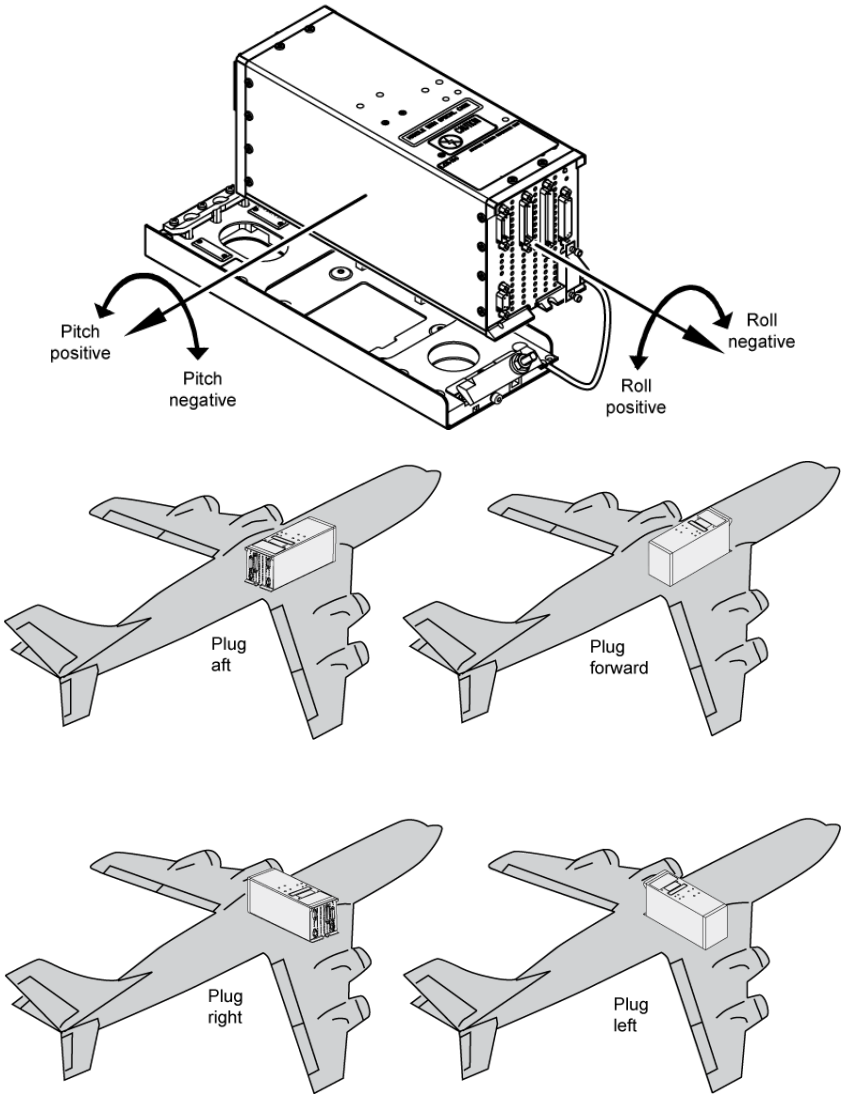


Figure 3-11 AHRU pitch/roll sense and mounting positions for ADI check

4.3 Trouble Shoot AHRS Problems

4.3.1 General Description

The Northrop Grumman LITEF GmbH AHRS performs two sets of BIT (Built In Tests), one set is performed at power up and another one is performed continuously. If one or more of the tests are faulty, an error indication will prompt the pilot or ground crew for incorrect operation of the AHRS and the Fault Indicator on the front plate of the AHRU will be set. At this time the AHRS will output the results of the BIT tests on Label 350 through 353 (refer to activity 1.1(7)). Most of the test results will be latched and at power down this information will be stored in the internal memory and can be downloaded from the AHRS (refer to section 3, paragraph 4.3.7.5) using special equipment.

4.3.2 Check Fault Indicator

If the LED on the front plate of the AHRU is flashing:

- Try to reset fault indicator by pressing the push button.
- If reset is successful: failure is not present any more. The failure can be evaluated by reading out the BIT history.
- If reset is not successful: AHRU must be checked because fault is still present (refer to paragraph 4.3.4 of this section).

4.3.3 Recommended Tools

- To perform activities as described in paragraph 1.1, you will need an ARINC 429 Bus reader and ARINC breakout cable to read one of the six ARINC busses from the AHRS. Alternatively, the Break Out box as part of the Northrop Grumman LITEF GmbH Level 1 Maintenance Set may be used.
- To perform activities as described in section 2, paragraph 5.8 it is recommended to use the Northrop Grumman LITEF GmbH Level 1 Maintenance Set.

4.3.4 Fault is still present AND you have an ARINC 429 Bus reader

- Power down the AHRS pulling the circuit breakers and connect the Bus Reader with the ARINC break out cable.
- Connect the ARINC Break-Out Cable also with LCR-100.
- Connect the ARINC Reader with the Break-Out Cable.
- Power up the AHRS.
- Check with the ARINC reader Labels 350 through 353. If there is any fault indication, one or more of the data bits are set to '1', please refer to paragraph 5.2 in this section.

4.3.5 Fault is not present OR you do not have a ARINC 429 Bus reader

In this case the stored records of the BIT History will be downloaded and analyzed. To do this you need either the Level 1 Maintenance Set or an equivalent test tool to read the BIT History. Northrop Grumman LITEF GmbH recommends using the Northrop Grumman LITEF GmbH tool because the SW will be maintained on regular basis. New SW will be distributed to all users or on request. It is assumed that the SW has been successfully installed on a desktop or laptop computer. Please refer to the appropriate pages in the User Manual.

- Power down the AHRS (pulling the circuit breaker).
- Connect the J6 connector with the AHRS and A/C wiring.
- Connect computer with L1MS Break Out box.
- Switch Test Mode to ON and turn on power to the AHRS.
- Start Level 1 software on the computer.

4.3.6 Selftest Data Output

Functional self test can be activated when aircraft is on ground and the selftest data discrete is activated.

For values of selftest data output refer to section 1, paragraph 5.1.

4.3.7 Failure Indication

4.3.7.1 Fault Indicator

The fault indicator is set active and latched if the BIT detects an AHRU hardware related failure. If the fault indicator is set active, the LED on the front plate of the AHRU flashes with a frequency of 1 Hz.

After the next power up, the fault indicator remains active (e.g. LED still flashing).

The fault indicator can be deactivated by pressing the mode button on the front plate of the AHRU if no BIT detected failure exists anymore and the system is either in the alignment or in the operational mode. After pressing the mode button the LED flashes 10 times at a rate of 4 Hz. If the fault indicator is set active, the MSU calibration mode cannot be entered by using the mode button.

4.3.7.2 ARINC 429 Output during Normal Operation

DITS Labels 350 - 353 contain discrete information that is helpful in fault finding. This information represents the actual failure status of the system and will be provided during normal operation.

4.3.7.3 Failure Logging and Malfunction Storage

The system records failure data.

The stored data is marked with the time tag derived from the elapsed time counter, the current system time (Label 302), the current temperature and the status of the air/ground discrete.

4.3.7.4 Elapsed Time Counter

The elapsed time counter indicates the total operating system time. The range of elapsed time recording is more than 100,000 hours.

4.3.7.5 Output of the Failure History and Elapsed Time

In maintenance test mode the failure history and the elapsed time are output by the means of the L1MS via the activated test interface.

4.3.7.6 Maintenance Output via Test Interface

The elapsed time is transmitted with a resolution of 0.1 hours. The complete BIT history is transmitted cyclically.

5 System Integrity

5.1 General

This chapter deals with the output state of the system during normal operation and for any detected failure either internal to the system or to the inputs. The monitoring and warning criteria are stated and shown in paragraph 5.3, summarizing the no computed data (NCD) conditions. DITS SSM Failure Annunciation is provided in Table 3-12.

5.2 Maintenance Discrete Outputs

DITS Labels 350 - 353 contain discrete information that is helpful in fault finding. This information represents the actual failure status of the system and will be provided during normal operation. Table 3-7 to Table 3-10 define the allocation of these bits.

In case the fault indicator (LED on the front panel of AHRU) is flashing (refer to Figure 1-9), then read out and check the BIT history entry for failure information. Check the bits set on Label 350-353 and continue with the proposed action given in Table 3-7 to Table 3-10.

Proposed general corrective action

If the failure is caused by the AHRU, than first try to reset fault indicator. In most cases the failure disappears. Only if reset is not possible and the proposed actions in the tables do not help it is necessary to return AHRU for Repair.

If the failure is not caused by the AHRU but on A/C side (e.g. wiring, electrical or digital interface) or on one of the AHRS-components (e.g. IDM, MSU, Tray…) and not on the AHRU itself, it is sufficient to reset the fault indicator (only possible, if external fault is eliminated).

How to reset the fault indicator

The fault indicator can be reset when the AHRU is switched on by pressing the Mode Button on the front side of the AHRU (refer to Figure 1-7) for minimum 2 seconds.

Label 350

Bit No.	Function	BIT Test ID	Possible cause	Corrective Action
1-8	Label			
9-10	SDI			
11	System Fault Indicator (1)			
12	NV RAM Fail	0007, 0017	AHRU defective	Proposed general corrective action, page 3031
13	Oscillator Divider Fail	0002	AHRU defective	Proposed general corrective action, page 3031
14	SRAM Fail	0005, 0015	AHRU defective	Proposed general corrective action, page 3031
15	Flash Fail	0016, 0031	AHRU defective	Proposed general corrective action, page 3031
16	IDM Fail	0070, 0071, 0072, 0073, 0074	IDM not installed IDM defective AHRU defective	Check IDM installation (Connect with AHRU-Connector 1J5) Replace IDM (2) Proposed general corrective action, page 3031
17	Not used (always 0)			
18	Scheduler Fail	0014	AHRU defective	Proposed general corrective action, page 3031
19	Not used (always 0)			
20	Watchdog Fail	0004	AHRU defective	Proposed general corrective action, page 3031
21	PIC Fail	0018	AHRU defective	Proposed general corrective action, page 3031
22	Not used (always 0)			
23	Processor Fail	0001	AHRU defective	Proposed general corrective action, page 3031
24	Start Up Occasion Fail	0003, 0013	AHRU defective	Proposed general corrective action, page 3031
25	Not used (always 0)			
26	Illegal Exception Fail	0011, 0012	AHRU defective	Proposed general corrective action, page 3031
27	Fan Supply Monitor	0084	Insufficient or excessive current to fan	Check installation; Check Fan supply voltage and current 24 V/80 mA. Replace Tray with fan if current less than 25 mA or more than 160 mA (3): Return Tray for Repair
28	PM FPGA Wrap Around Fail	0008	AHRU defective	Proposed general corrective action, page 3031
29	No DADS information available		No data from DADS or ARINC input defective	Check wiring/installation Check ARINC input Proposed general corrective action, page 3031
30-31	SSM			
32	Parity (odd)			

Table 3-7 Maintenance Discrete Word 1 (Label 350)

1) Bit will be set when fault indicator is set
2) If possible transfer the data from the defective to the new IDM using L1MS.
3) When replacing a defective with a new tray, it is necessary to re-align it!

Label 351

Bit No.	Function	Bit Test ID	Possible Cause	Proposed Action for Customers
1 - 8	Label			
9 - 10	SDI			
11-13	Not used, always 0			
14	Maintenance Flag	0124	Degradation	Proposed general corrective action, page 3031
15	Gyro Warn	0120	Degradation Overrange or Overtemperature	Proposed general corrective action, page 3031
16	Gyro NOGO	0121	AHRU defective	Proposed general corrective action, page 3031
17	Max. Angular Rate exceeded	0108	Excessive rates (more than 600°/s) occurred AHRU defective	Check plausibility of excessive rates Proposed general corrective action, page 3031
18	Not used (always 0)			
19	Accelerometer Warn	0122	Overrange or Overtemperature	No action
20	Accelerometer NOGO	0123	AHRU defective	Proposed general corrective action, page 3031
21	IMU NOGO	0106	AHRU defective	Proposed general corrective action, page 3031
22	IMU Interface Time Out Fail	0110, 0111	AHRU defective	Proposed general corrective action, page 3031
23	IMU Interface Data Fail	0112, 0113	AHRU defective	Proposed general corrective action, page 3031
24	IMU Interface Sequence Fail	0114, 0115	AHRU defective	Proposed general corrective action, page 3031
25	Accelerometer Not Initialized	0125, 0126	AHRU defective	Proposed general corrective action, page 3031
26	Max. Acceleration exceeded	0107	Excessive acceler-ation (more than 10g) occurred AHRU defective	Check plausibility of excessive accelerations Proposed general corrective action, page 3031
27	Vertical Earth Rate Fail	0101	AHRU defective	Proposed general corrective action, page 3031
28	Not used (always 0)			
29	Vertical Acceleration Bias Fail	0109	To high change in pressure altitude AHRU defective	Check if pressure altitude input from DADS has shown jumps or high ramps e.g. induced by tests Proposed general corrective action, page 3031
30-31	SSM			
32	Parity (odd)			

Table 3-8 Maintenance Discrete Word 2 (Label 351)

Label 352

Bit No.	Function	Bit Test ID	Possible Cause	Proposed Action for Customers
1-8	Label			
9-10	SDI			
11	PM DITS Receiver Overflow	0032, 0033	AHRU defective	Proposed general corrective action, page 3031
12	PM DITS Transmitter Not Ready	0020	AHRU defective	Proposed general corrective action, page 3031
13	PM DITS Wrap Around Fail	0021	AHRU defective	Proposed general corrective action, page 3031
14	IFM DITS Receiver Overflow	0047	AHRU defective	Proposed general corrective action, page 3031
15	IFM DITS Transmitter Not Ready	0048	AHRU defective	Proposed general corrective action, page 3031
16	IFM DITS Wrap Around Fail	0049	AHRU defective	Proposed general corrective action, page 3031
17	ADC Fail	0041, 0050	AHRU defective	Proposed general corrective action, page 3031
18	DAC Fail	0042, 0051	AHRU defective	Proposed general corrective action, page 3031
19	IFM Discrete Output Fail	0052	AHRU defective	Proposed general corrective action, page 3031
20	MSU Reference Input Fail	0055	No input signal at J4-60 availa-ble AHRU defective	Check availability of jumper J4-39- to J4-60 Proposed general corrective action, page 3031
21	Program Pin Fail	0043, 0058	Parity of program pins incorrect AHRU defective	Check installation/wiring Proposed general corrective action, page 3031
22	MSU Connection Fail	0054	MSU not connected AHRU defective	Check installation/wiring Return AHRU for Repair
23	MSU Short Circuit	0044, 0053	MSU input short circuit AHRU defective	Check installation/wiring Proposed general corrective action, page 3031
24	MSU Excitation Fail	0046	AHRU defective	Proposed general corrective action, page 3031
25	Not used (always 0)			
26	SPI Communication Test	0022, 0023	AHRU defective	Proposed general corrective action, page 3031
27	IFM FPGA Test Register Test	0060, 0061	AHRU defective	Proposed general corrective action, page 3031
28	IFM FPGA Wrap Around Fail	0040	AHRU defective	Proposed general corrective action, page 3031
29	GNSS Time Mark Fail	0057	Interface to GPS receiver time mark AHRU defective	Check installation/wiring Check GPS time mark signal Proposed general corrective action, page 3031
30-31	SSM			
32	Parity (odd)			

Table 3-9 Maintenance Discrete Word 3 (Label 352)

Label 353

Bit No.	Function	BIT Test ID	Possible Cause	Proposed Action for Customers
1-8	Label			
9-10	SDI			
11	Not used			
12	Synchro E²PROM Fail	0200	AHRU defective	Proposed general corrective action, page 3031
13	Synchro SPI Fail	0202 - 0205	AHRU defective	Proposed general corrective action, page 3031
14	Attitude Reference Unavailable	0232	No external input or input voltage form AHRU defective	Check wiring to/from 26V/400Hz; Check waveform of input (1) Proposed general corrective action, page 3031
15	Heading Reference 1 Unavailable	0233	No external input or input voltage form AHRU defective	Check wiring to/from 26V/400Hz Check waveform of input (1) Proposed general corrective action, page 3031
16	Heading Synchro 1 Fail	0230	Short circuit in wiring AHRU defective	Check wiring to/from synchros Proposed general corrective action, page 3031
17	Roll Synchro Fail	0228	Short circuit in wiring AHRU defective	Check wiring to/from synchros Proposed general corrective action, page 3031
18	Pitch Synchro Fail	0229	Short circuit in wiring AHRU defective	Check wiring to/from synchros Proposed general corrective action, page 3031
19	Yaw Rate DC Output Fail	0236	Short circuit in wiring AHRU defective	Check wiring Proposed general corrective action, page 3031
20	Turn Rate DC Output Fail	0235	Short circuit in wiring AHRU defective	Check wiring to/from synchros Proposed general corrective action, page 3031
21	SIM Discrete Output Fail	0211	AHRU defective	Proposed general corrective action, page 3031
22	Heading Synchro 2 Fail	0231	Short circuit in wiring AHRU defective	Check wiring to/from synchros Proposed general corrective action, page 3031
23	Heading Reference 2 Unavailable	0234	No external input or input voltage form AHRU defective	Check wiring to/from 26V/400Hz Check waveform of input (1) Proposed general corrective action, page 3031
24	Normal Acceleration DC Output Fail	0237	Short circuit in wiring AHRU defective	Check wiring Proposed general corrective action, page 3031
25	SIM ADC Fail	0224	AHRU defective	Proposed general corrective action, page 3031
26-29	Not used			
30-31	SSM			
32	Parity (odd)			

Table 3-10 Maintenance Discrete Word 4 (Label 353)

1) Waveform of input: sinusoidal, according DO-160E, section 16.4

5.3 AHRS Fault Monitoring Summary

The following table itemizes each failure condition, data validity check and software test in the system which contributes to the fault monitoring. Then, the logic for combining these to produce the WARN, BITE and SHUTDOWN conditions is provided, together with the discrete output on Label 270 and 271 and the failure warning in SSM of the digital binary ARINC outputs.

Flight critical failures, i.e. failures which may generate misleading information and affect aircraft safety, will cause an AHRU shut-down and are marked in the SHUTDOWN column.

The discrete outputs heading, attitude, yaw rate, turn rate and AHRS warn are also indicated on Label 271.

An indication is given as to which tests are latched, after the first failure, to a permanently set state.

NOTE

The numbers in columns Label 270 and 271 indicate which bits within the corresponding word are set to "1". Numbers marked by an asterisk indicates the "0" state of these bits.

Definition of Reset Hold mode (refer to Table 3-11)

- No ARINC output
- Analog output frozen (Only applicable for systems with embedded synchro interface module; P/N: 145130-2XXX and -7XXX)
- Synchro output warn discrete: set to warn

				Warn Discrete Output							Discrete Words					
Test ID	**Monitoring Test Performed by the system**	**Test Phase**	**Reaction Time**	**HDG Warn 1 + 2**	**ATT Warn**	**Yaw / Turn Rate Warn**	**System Warn**	**Fault Indicator**	**Reset Hold**	**Fail Latched = L**	**Bit in Label 270**	**Bit in Label 271 (1)**	**Maintenance Discrete Label/Bit**	**SSM on DITS (2)**	**Bit history Entry**	**C: Comment D: Diagnostic Information F: Fault Reaction**
0001	Processor Test	P	N/A	x	x	x	x	x	x	x	15, 16, 19	14, 15, 16, 17, 21	350/23		x	
0002	Check of Oscillator Divider	P	N/A	x	x	x	x	x	x	x	15, 16, 19	14, 15, 16, 17, 21	350/13		x	D: Value of Divider Register
0003	Startup Occasion Test	P	N/A	x	x	x	x	x	x	x	15, 16, 19	14, 15, 16, 17, 21	350/24		x	
0004	Watchdog Test	P	N/A	x	x	x	x	x	x	x	15, 16, 19	14, 15, 16, 17, 21	350/20		x	
0005	Startup SRAM Test	P	N/A	x	x	x	x	x	x	x	15, 16, 19	14, 15, 16, 17, 21	350/14		x	D: Address of fault cell in SRAM, altitude
0031	Startup Flash Test	P	N/A	x	x	x	x	x	x	x	15, 16, 19	14, 15, 16, 17, 21	350/15		x	D: Failed Data Block
0007	Startup NV RAM Test	P	N/A				x	x		x	19	17	350/12	Normal	x	D: Failed NV RAM address or block number. F: Airborne, failure annunciation suppressed until 60s after landing; Short Power Interrupt disabled
0008	PM FPGA Wrap Around Test	P					x	x		x	19	17	350/28	Fault on all Labels in faulty channel	x	D: ARINC channel
0011	Illegal Exception	C	1s	x	x	x	x	x	x	x	15, 16, 19	14, 15, 16, 17, 21	350/26		x	D: Program Counter, Exception number
0012	Illegal Trap Exception Test	C	2s	x	x	x	x	x	x	x	15, 16, 19	14, 15, 16, 17, 21	350/26		x	D: Program Counter
0013	Program Cycle Test	C	2s										350/24			F: Hardware Reset
0014	Scheduler Test	C	2s	x	x	x	x	x	x	x	15, 16, 19	14, 15, 16, 17, 21	350/18		x	D: Task ID
0015	Continuous SRAM Test	C	1s	x	x	x	x	x	x	x	15, 16, 19	14, 15, 16, 17, 21	350/14		x	D: Address, altitude
0016	Continuous Flash Test	C	1s	x	x	x	x	x	x	x	15, 16, 19	14, 15, 16, 17, 21	350/15		x	D: Address, altitude
0017	Continuous NV RAM Test	C	1s				x	x		x	19	17	350/12	Normal	x	D: Failed NV RAM address or block number, altitude F: Short Power Interrupt disabled; If airborne, failure annunciation suppressed until 60s after landing
0018	PIC Test	C	1s				x	x			19	17	350/21	Normal	x	D: PIC status F: Short Power Interrupt disabled; If airborne, failure annunciation suppressed until 60s after landing
0032	DITS PM Receiver Overflow channel 3 and 4	C	100 ms				x	x		x	19	17	352/11	Normal	x	D: ARINC channel F: Hybrid Free inertial operation and indication (Label 274)
0033	DITS PM Receiver Overflow channel 5 and 6	C	100 ms	x	x	x	x	x		x	15, 16, 19	14, 15, 16, 17, 21	352/11	All Labels NCD	x	D: ARINC channel

				Warn Discrete Output							Discrete Words					
Test ID	**Monitoring Test Performed by the system**	**Test Phase**	**Reaction Time**	**HDG Warn 1 + 2**	**ATT Warn**	**Yaw / Turn Rate Warn**	**System Warn**	**Fault Indicator**	**Reset Hold**	**Fail Latched = L**	**Bit in Label 270**	**Bit in Label 271 (1)**	**Maintenance Discrete Label/Bit**	**SSM on DITS (2)**	**Bit history Entry**	**C: Comment D: Diagnostic Information F: Fault Reaction**
	SPI Communication Test															
0022	Synchro SPI	C		x	x	x	x	x		x	16, 19	14, 15, 16, 17, 21	352/26	Normal	x	
0023	MSU ADC SPI	C		x		x	x	x		x	16, 19	14, 17, 21	352/26	Type 1	x	C: In Navigation or ATT/DG mode, test is disabled
0040	IFM FPGA Wrap Around Test	P	N/A				x	x		x	19	17	352/28	Fault on all Labels in faulty channel	x	D: ARINC channel
0041	SPI ADC Test	P	N/A					x			19		352/17		x	D: Failed ADC channel
0042	SPI DAC Test	P	N/A				x	x		x	19	17	352/18		x	
0043	Program Pin Test	P	N/A	x	x	x	x	x		x	15, 16, 19	14, 15, 16, 17	352/21	Type 4	x	D: Value of all program pins C: Test disabled in test mode
0044	MSU Short Circuit Test	P	N/A					x			19		352/23	Type 1	x	D: measured value
0045	MSU Connection Test	P	N/A									22				C: Test disabled for P/N 145130-6xxx and -7xxx F: If this test fails the tests 0041, 0042, 0046, 0050, 0053, 0054 and 0055 are disabled. MAG mode and MSU Calibration mode disabled
0046	MSU Excitation Test	P	N/A					x			19		352/24		x	D: measured value
0047	DITS IFM Receiver Overflow Test	C	100 ms				x	x		x	19	17	352/14	Normal	x	D: ARINC channel F: P/N -1002 and -1005 Hybrid: if channel 1, Free inertial indication (Label 274)
0048	DITS IFM Transmitter Not Ready Test	C	100 ms					x		x	19	17	352/15	Fault on all Labels in faulty channel	x	D: ARINC channel
0049	DITS IFM Wrap Around Test	C	1s				x	x		x	19	17	352/16	Fault on all Labels in faulty channel	x	D: ARINC channel
0050	A/D Converter Continuous Test	C	1s	x			x	x			16, 19	14, 17	352/17	Type 1	x	F: Airborne in Navigation Mode or attitude/DG mode failure annunciation suppressed until 60s after landing.

				Warn Discrete Output							Discrete Words					
Test ID	**Monitoring Test Performed by the system**	**Test Phase**	**Reaction Time**	**HDG Warn 1 + 2**	**ATT Warn**	**Yaw / Turn Rate Warn**	**System Warn**	**Fault Indicator**	**Reset Hold**	**Fail Latched = L**	**Bit in Label 270**	**Bit in Label 271 (1)**	**Maintenance Discrete Label/Bit**	**SSM on DITS (2)**	**Bit history Entry**	**C: Comment D: Diagnostic Information F: Fault Reaction**
0051	Slaving Error Wrap Around Test	C	1s				x	x		x	19	17	352/18	Normal	x	
0052	IFM Discrete Output Test	P	N/A	x	x	x	x	x	x	x	15, 16, 19	14, 15, 16, 17, 21	352/19		x	
0053	MSU Cont. Short Circuit Test	C	1s	x			x	x			16, 19	14, 17	352/23	Type 1	x	D: measured value F: Airborne in Navigation Mode or attitude/DG mode failure annunciation suppressed until 60s after landing.
0054	MSU Cont. Connection Test	C	1s	x			x	x			16, 19	14, 17, 22	352/22	Type 1	x	
0055	MSU Reference Input Test	C	1s	x			x				16	14, 17	352/20	Type 1	x	F: Airborne in Navigation Mode or attitude/DG mode failure annunciation suppressed until 60s after landing.
0056	MSU Data Test	C	100 ms									23		Normal		C: In Navigation Mode or attitude/DG mode fault reaction suppressed.
0057	GPS Time Mark Test	C	100 ms										352/29	Normal	x	D: Failed channel F: Hybrid navigation free inertial. C: Test disabled in test mode
0058	Program Pin Continuous Test	C	1s				x	x			15, 16, 19	14, 15, 16, 17	352/21	Type 4	x	D: Value of all program pins F: Airborne, failure annunciation suppressed until 60s after landing.
0059	IFM Discrete Output Test	C	200 ms	x	x	x	x	x	x	x	15, 16, 19	14, 15, 16, 17, 21	352/19		x	
0060	FPGA Test Register Test	P	N/A	x	x	x	x	x	x	x	15, 16, 19	14, 15, 16, 17, 21	352/27		x	
0061	FPGA Test Register Test	C	100 ms	x	x	x	x	x	x	x	15, 16, 19	14, 15, 16, 17, 21	352/27		x	
0070	MSU CalProm Test	P	N/A	x			x	x		x	16, 19	14, 17	350/16	Type 1	x	F: Airborne failure annunciation suppressed until 60s after landing. C: Test disabled in test mode
0071	Mounting Correction Test	P	N/A	x	x	x	x	x		x	15, 16, 19	14, 15, 16, 17, 21	350/16	Type 4	x	
0072	Lever Arm Test	P	N/A				x	x		x	19	17	350/16	Normal	x	
0073	GPS Lever Arm Test	P	N/A				x	x		x	19	17	350/16		x	
0074	MAGVAR Model Data Test	P	N/A				x	x		x	19	17	350/16	Type 7	x	
0080	Power Supply Monitor	C	1 ms	x	x	x	x									F: Shutdown C: Pure Hardware Function
0081	Line Voltage Monitor	C	N/A	x	x	x	x									
0082	Boost Overvoltage Monitor	C	N/A	x	x	x	x									
0083	DC/DC Converter Monitor	C	N/A	x	x	x	x									
0084	Fan Supply Monitor	C	1s				x			x		13, 17	350/27 356/21	Normal	x	C: Test performed on ground only, after landing test disabled for 60s
0101	Vertical Earth Rate	C					x	x		x	19	17	351/27	Normal	x	

				Warn Discrete Output							Discrete Words					
Test ID	**Monitoring Test Performed by the system**	**Test Phase**	**Reaction Time**	**HDG Warn 1 + 2**	**ATT Warn**	**Yaw / Turn Rate Warn**	**System Warn**	**Fault Indicator**	**Reset Hold**	**Fail Latched = L**	**Bit in Label 270**	**Bit in Label 271 (1)**	**Maintenance Discrete Label/Bit**	**SSM on DITS (2)**	**Bit history Entry**	**C: Comment D: Diagnostic Information F: Fault Reaction**
	IMU Interface Time Out Test	C	2.5 ms													
0110	3 fails during power cycle						x	x		x	19	17	351/22		x	F: change to attitude mode
0111	Failure rate exceeding 1 per 400 messages			x	x	x	x	x		x	15, 16, 19	14, 15, 16, 17, 21	351/22	Type 4	x	D: number of failed tests since power on, max. delay
	IMU Interface Data Test	C	2.5 ms													
0112	3 fails during power cycle						x	x		x	19	17	351/23		x	F: change to attitude mode
0113	Failure rate exceeding 1 per 400 messages			x	x	x	x	x		x	15, 16, 19	14, 15, 16, 17, 21	351/23	Type 4	x	D: number of failed tests since power on
	IMU Interface Sequence Test	C	2.5 ms												x	
0114	3 fails during power cycle						x	x		x	19	17	351/24		x	F: change to attitude mode
0115	Failure rate exceeding 1 per 400 messages			x	x	x	x	x		x	15, 16, 19	14, 15, 16, 17, 21	351/24	Type 4	x	D: number of failed tests since power on
	IMU BIT Status	C	2.5 ms													
0120	Gyro Warn						x	x			19	17	351/15	Normal	x	C: Test disabled in attitude mode F: Fault reaction after 30s continuous fail, change to attitude mode D: IMU status word
0121	Gyro Nogo			x	x	x	x	x		x	15, 16, 19	14, 15, 16, 17, 21	351/16	Type 4	x	D: IMU status word
0122	Accelerometer Warn						x	x			19	12, 17	351/19	Normal	x	C: Test disabled in attitude mode F: Fault reaction after 30s continuous fail, change to attitude mode D: IMU status word
0123	Accelerometer Nogo			x	x	x	x	x		x	15, 16, 19	12, 14, 15, 16, 17, 21	351/20	Type 4	x	D: IMU status word
0124	Maintenance Flag						x	x			19	17				F: Fault reaction after 100s continuous fail, Failure reaction suppressed in air until 60s after landing D: IMU status word
0125	Accelerometer Not Initialized												351/25	Type 6	x	D: IMU status word F: Fault reaction suppressed in air until 60s after landing
0126	Accelerometer Not Initialized			x	x	x	x	x		x	15, 16, 19	12, 14, 15, 16, 17, 21	351/25	Type 4	x	D: IMU status word
0106	IMU NOGO	C	5ms	x	x	x	x	x		x	15, 16, 19	12, 14, 15, 16, 17, 21	351/21	Type 4	x	D: IMU status word
0107	Max Acceleration Exceeded	C	5ms	x	x	x	x			x	15, 16	14, 15, 16, 17, 21	351/26	Type 5	x	C: recovery only after power off
0108	Max Angular Rate Exceeded	C	5ms	x	x	x	x			x	15, 16	12, 14, 15, 16, 17, 21	351/17	Type 5	x	C: recovery only after power off
0109	Vertical Acceleration Bias Test	C					x	x		x	19	17	351/29	Normal	x	C: test only performed airborne when valid pressure altitude is available. D: Vertical Acceleration Bias

				Warn Discrete Output							Discrete Words					
Test ID	**Monitoring Test Performed by the system**	**Test Phase**	**Reaction Time**	**HDG Warn 1 + 2**	**ATT Warn**	**Yaw / Turn Rate Warn**	**System Warn**	**Fault Indicator**	**Reset Hold**	**Fail Latched = L**	**Bit in Label 270**	**Bit in Label 271 (1)**	**Maintenance Discrete Label/Bit**	**SSM on DITS (2)**	**Bit history Entry**	**C: Comment D: Diagnostic Information F: Fault Reaction**
0200	E²PROM Test	P	N/A	x	x	x	x	x		x	16, 19	14, 15, 16, 17, 21	353/12	Normal	x	
0202	Synchro SPI-Interface Wrap Around MDAC Test	P	N/A	x	x		x	x		x	16, 19	14, 15, 17	353/13	Normal	x	
0203	Synchro SPI-Interface Wrap Around MDAC Test	C	10 ms	x	x		x	x		x	16, 19	14, 15, 17	353/13	Normal	x	
0204	Synchro SPI-Interface Wrap Around Relay Test	P	N/A	x	x	x	x	x	x	x	16, 19	14, 15, 16, 17, 21	353/13	Normal	x	
0205	Synchro SPI-Interface Wrap Around Relay Test	C	10 ms	x	x	x	x	x	x	x	16, 19	14, 15, 16, 17, 21	353/13	Normal	x	
0211	SIM Discrete Output Test	C	500 ms	x	x	x	x	x	x	x	15, 16, 19	14, 15, 16, 17, 21	353/21	Normal	x	D: Faulty Discrete
0224	ADC Test	C	1s	x	x	x	x	x		x	16, 19	12, 14, 15, 16, 17, 21	353/25	Normal	x	
0228	Roll Synchro Angle Test	C	1s		x		x	x			19	15, 17	353/17	Normal	x	D: transmitted and read back values
0229	Pitch Synchro Angle Test	C	1s		x		x	x			19	15, 17	353/18	Normal	x	
0230	HDG 1 Synchro Angle Test	C	1s	1			x	x			16, 19	14, 17	353/16	Normal	x	
0231	HDG 2 Synchro Angle Test	C	1s	2			x	x			16, 19	14, 17	353/22	Normal	x	
0232	Synchro Attitude Reference Voltage Test	C	1s		x		x					15, 17	353/14	Normal		D: measured value F: tests 0228 and 0229 disabled
0233	Synchro HDG 1 Reference Voltage Test	C	1s	1			x				16	14, 17	353/15	Normal		D: measured value F: test 0230 disabled
0234	Synchro HDG 2 Reference Voltage Test	C	1s	2			x				16	14, 17	353/23	Normal		D: measured value F: test 0231 disabled
0235	Turn Rate DC Test	C	1s			T	x				19	17, 21	353/20	Normal	x	D: Expected and read back voltages
0236	Yaw Rate DC Test	C	1s			Y	x				19	16, 17	353/19	Normal	x	
0237	Normal Acceleration DC Test	C	1s				x				19	12, 17	353/24	Normal	x	

Table 3-11 Test Catalogue and Fault Reaction

1) Bit 16 in Label 271 only applicable for systems with installed synchro interface module (LCR-100 P/N 145130-2xxx and –7xxx)

2) SSM Annunciation related to failure types in table DITS SSM Failure Annunciation (refer to Table 3-12)

5.3.1 DITS SSM Failure Annunciation

Label	Parameter	Type 1 (MSU Heading related)	Type 2 (Gyro related)	Type 3 (Accelero-meter re-lated)	Type 4 (IMU and Platform related)	Type 5 (Rate/Acce-leration re-lated)	Type 6 (Accelero-meter reset related)	Type 7 MAGVAR Model loss related
040	Body Turn Rate		Fault		Fault	NCD (1)		
046	Software Version							
151	System Discrete 4							
152	System Discrete 5							
155	Configuration Discrete 1							
156	Configuration Discrete 2							
270	System Discrete 1							
271	System Discrete 2							
272	System Discrete 3							
275	Command Discrete							
300	Magnetic Sensor Input	Fault						
301	Body Normal Accel.			Fault	Fault	NCD (3)		
302	System Time							
303	Input Discrete 1							
304	Input Discrete 2							
305	Alignment Countdown							
306	MSU Fieldstrength	Fault						
314	True Heading		Fault	Fault	Fault	NCD		
320	Mag Heading	Fault (7)	Fault	Fault	Fault	NCD		(9)
324	Pitch Angle		Fault	Fault	Fault	NCD		
325	Roll Angle		Fault	Fault	Fault	NCD		
326	Body Pitch Rate		Fault		Fault	NCD (1)		
327	Body Roll Rate		Fault		Fault	NCD (1)		
330	Body Yaw/ Turn Rate (8)		Fault		Fault	NCD (1)		
331	Body Long. Acceleration			Fault	Fault	NCD (2)	NCD	
332	Body Lat. Acceleration			Fault	Fault	NCD (2)	NCD	
333	Body Normal Acceleration			Fault	Fault	NCD (2)	NCD	
334	Magnetic Sensor Input	Fault						
336	Pitch Attitude Rate		Fault	Fault	Fault	NCD (1)		
337	Roll Attitude Rate		Fault	Fault	Fault	NCD (1)		
340	Turn rate (8)		Fault		Fault	NCD (1)		
350 – 353	Maintenance Discr. 1 – Maintenance Discr. 4							
354	MSU Calibration Error							
356	System Input Status							
361	Inertial Altitude		NCD	NCD	NCD	NCD		
364	Vertical Acceleration		NCD	Fault	Fault	NCD	NCD	
365	Inertial Vertical Speed		NCD	NCD	NCD	NCD		
375	Along Hdg. Acceleration		NCD	Fault	Fault	NCD	NCD	
376	Cross Hdg. Acceleration		NCD	Fault	Fault	NCD	NCD	
377	Equipment Identification							
147	Magnetic Variation		NCD	NCD	NCD	NCD		
310	Present Pos Lat		Fault	Fault	Fault	NCD		
311	Present Pos Long		Fault	Fault	Fault	NCD		
312	Ground Speed		Fault	Fault	Fault	NCD		
313	Track Angle True		Fault	Fault	Fault	NCD		
315	Wind Speed		Fault	Fault	Fault	NCD (5)		

Label	Parameter	Type 1 (MSU Heading related)	Type 2 (Gyro related)	Type 3 (Accelero-meter re-lated)	Type 4 (IMU and Platform related)	Type 5 (Rate/Acce-leration re-lated)	Type 6 (Accelero-meter reset related)	Type 7 MAGVAR Model loss related
316	Wind Direct True		Fault	Fault	Fault	NCD		
317	Track Angle (Mag)		Fault	Fault	Fault	NCD		Fault
321	Drift Angle		Fault	Fault	Fault	NCD		
322	Flight Path Angle		Fault	Fault	Fault	NCD		
323	Flight Path Accel		Fault	Fault	Fault	NCD (2)	NCD	
335	Track Angle Rate		Fault	Fault	Fault	NCD		
360	Potential Vert Speed (10)		Fault	Fault	Fault	NCD		
362	Along Tk Horiz. Acceleration		Fault	Fault	Fault	NCD	NCD	
363	Cross Tk Horiz. Acceleration		Fault	Fault	Fault	NCD	NCD	
366	N-S Velocity		Fault	Fault	Fault	NCD		
367	E-W Velocity		Fault	Fault	Fault	NCD		
372	Wind Direction Magnetic		Fault	Fault	Fault	NCD		Fault
373	N-S Velocity Mag		Fault	Fault	Fault	NCD		Fault
374	E-W Velocity Mag		Fault	Fault	Fault	NCD		Fault
055	Hybrid Mag Heading (10)	NCD (6)	NCD	NCD	NCD	NCD		Fault
104	Hybrid Wind Speed	NCD (6)	NCD	NCD	NCD	NCD (5)		
105	Hybrid Wind Direction True	NCD (6)	NCD	NCD	NCD	NCD		
106	Hybrid Wind Direction Mag	NCD (6)	NCD	NCD	NCD	NCD		Fault
132	Hybrid True Heading	NCD (6)	NCD	NCD	NCD	NCD		
134	Hybrid Potential Vert Spd	NCD (6)	NCD	NCD	NCD	NCD		
135	Hybrid Vertical FOM	NCD (6)	NCD	NCD	NCD	NCD		
137	Hybrid Track Angle	NCD (6)	NCD	NCD	NCD	NCD		
153	Hybrid Track Angle Mag	NCD (6)	NCD	NCD	NCD	NCD		Fault
154	Hybrid Track Angle Rate	NCD (6)	NCD	NCD	NCD	NCD (4)		
160	Hybrid Drift Angle	NCD (6)	NCD	NCD	NCD	NCD		
175	Hybrid Ground Speed	NCD (6)	NCD	NCD	NCD	NCD		
254	Hybrid Latitude	NCD (6)	NCD	NCD	NCD	NCD		
255	Hybrid Longitude	NCD (6)	NCD	NCD	NCD	NCD		
256	Hybrid Latitude Fine	NCD (6)	NCD	NCD	NCD	NCD		
257	Hybrid Longitude Fine	NCD (6)	NCD	NCD	NCD	NCD		
261	Hybrid Altitude (MSL)	NCD (6)	NCD	NCD	NCD	NCD		
262	Hybrid Flight Path Accel.	NCD (6)	NCD	NCD	NCD	NCD (2)	NCD	
263	Hybrid Flight Path Angle	NCD (6)	NCD	NCD	NCD	NCD		
264	Hybrid Horizontal FOM	NCD (6)	NCD	NCD	NCD	NCD		
266	Hybrid N-S Velocity	NCD (6)	NCD	NCD	NCD	NCD		
267	Hybrid E-W Velocity	NCD (6)	NCD	NCD	NCD	NCD		
274	Hybrid Status							
344	Hybrid Along HDG Velocity	NCD (6)	NCD	NCD	NCD	NCD		
345	Hybrid Vertical Velocity	NCD (6)	NCD	NCD	NCD	NCD		
346	Hybrid Across HDG Velocity	NCD (6)	NCD	NCD	NCD	NCD		

Table 3-12 DITS SSM Failure Annunciation

1) For rates in excess of ±128 deg/s
2) For accelerations in excess of ±4 g
3) For accelerations in excess of ±8 g
4) For rates in excess of ±32 deg/s
5) For wind speed > 256 knots and < 5 knots
6) NCD in attitude mode only, in navigation mode normal
7) Not in navigation mode (IRS operation)
8) For P/N 145130-3000 only. Label 330: Body Yaw Rate, Label 340: Turn Rate
9) Fault if System is in Navigation Mode
10) Label 360: Not for P/N 145130-3000; Label 055 for P/N 145130-3000 only

6 Use of the World Magnetic Model

The LCR-100 uses the NOAA World Magnetic Field Model (WMM).

In Navigation Mode the system algebraically adds computed magnetic variation from the current WMM to true heading and true track to produce magnetic heading and magnetic track angle.

Evaluation of the latest WMM

The WMM is updated every 5 years.

The LCR-100 versions utilize by default following NOAA World Magnetic Models:

AHRS	With IDM	Default WMM
145130-1XXX	124282-0000	WMM 2005
145130-1XXX	124282-2100	WMM 2010
145130-2XXX	124282-0000	WMM 2005
145130-2XXX	124282-2100	WMM 2010
145130-3000	124282-2100	WMM 2010

Table 3-13 LCR-100 WMM Versions

If an updated model is available from NOAA, this new model will be evaluated by NG LITEF to determine the changes in respect to the models in use. If the evaluation of the latest MagVar model against the models in use leads to a difference of more than ±2.5 degrees of deviation in areas of aircraft operation, it is recommended to update the magnetic model.

A Service Information Letter (SIL) will be issued for any NOAA magnetic model update which contains the results of the evaluation of the models.

Update to current WMM 2015 model:

Since april 2015 an update to WMM 2015 for LCR-100 systems with P/N 145130 -1XXX, -2XXX and -3000 from MOD 25 or higher is available. The WMM update will be performed by connecting a new Installation Data Module (IDM) with P/N 124282-2200. This IDM contains the WMM 2015 by factory setting. Programmed IDM User Data (as listed in section 2, Table 2-1) can be copied into the new IDM by usage of the Level One Maintenance Set P/N 309946-0000- -0100, -0500 or -0501.

Further details are published in SIL-145130-0019-845.

Time constrains

There are no time constrains. The update of the WMM to the current one can be done at any time.

SECTION 4

REMOVAL/INSTALLATION

1 General

This section provides installation and removal procedures for the AHRUs. The AHRUs may be located in the aircraft electronics rack or in an avionics bay.

The installation of the mounting tray is described in section 3, paragraph 3.1.

CAUTION

Before any work is carried out on the AHRS which involves the installation and removal of the AHRU, this section must be read thoroughly and understood. Failure to observe these procedures could lead to unnecessary damage to the equipment, e.g. to the gasket on the mounting tray.

Handle Units with care at all times. Mishandling could cause damage to sensitive components of the AHRU.

CAUTION

To prevent possible damage to the AHRS, always pull all AHRS-related aircraft circuit breakers out (off) before removing any unit.

CAUTION

To prevent possible damage to the AHRS, tighten the connector screws with a maximum torque of 0.4 + 0.1 Nm, respectively 3.5 + 0.9 in-lbs!

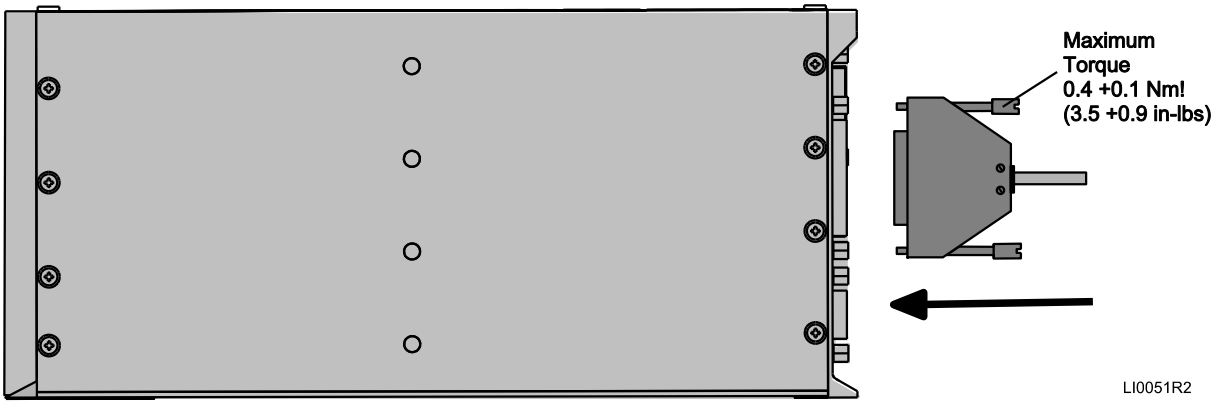


Figure 4-1 Fixing Torque for Connectors

2 Installation of the AHRU

For the following descriptions refer to Figure 4-2:

CAUTION

When performing the following step, do not use sharp-pointed tools to pry out the plug caps because the tools may pierce the plug cap and damage the connector pins.

(1) Remove protective caps from AHRU external connectors (we recommend to store the protective caps - you need them again as soon it is necessary to remove the AHRU)

CAUTION

The AHRU is sensitive to damage by electrostatic discharge. Use appropriate protective procedures.

CAUTION

Failure to perform the following step may cause damage to the AHRU connectors and/or mating connectors.

(2) Ensure that all connector pins are undamaged and straight, and that no foreign objects are in AHRU connectors and/or mating connectors.

(3) Ensure that all AHRS-related circuit breakers are off.

(4) Ensure that no tools or other items are in Mounting Tray or plenum.

(5) Install AHRU on the tray as shown in Figure 4-2 (view 2 and 3).

(6) Engage hold-down fastener.

(7) **LCR-100 mounting tray:**
Tighten nut with torque 7 -0.5 Nm (62 -4.0 in-lbs) (wrench size 10 mm).
Connect J1 through J6 (refer to Figure 1-9). (When the IDM is re-attached to J5 the existing compass compensation and mounting alignment correction constants are supplied to the replacement AHRU.)

LCR-92/93 mounting tray: Tighten self-torquing hold-down fastener by turning clockwise until it is tight.

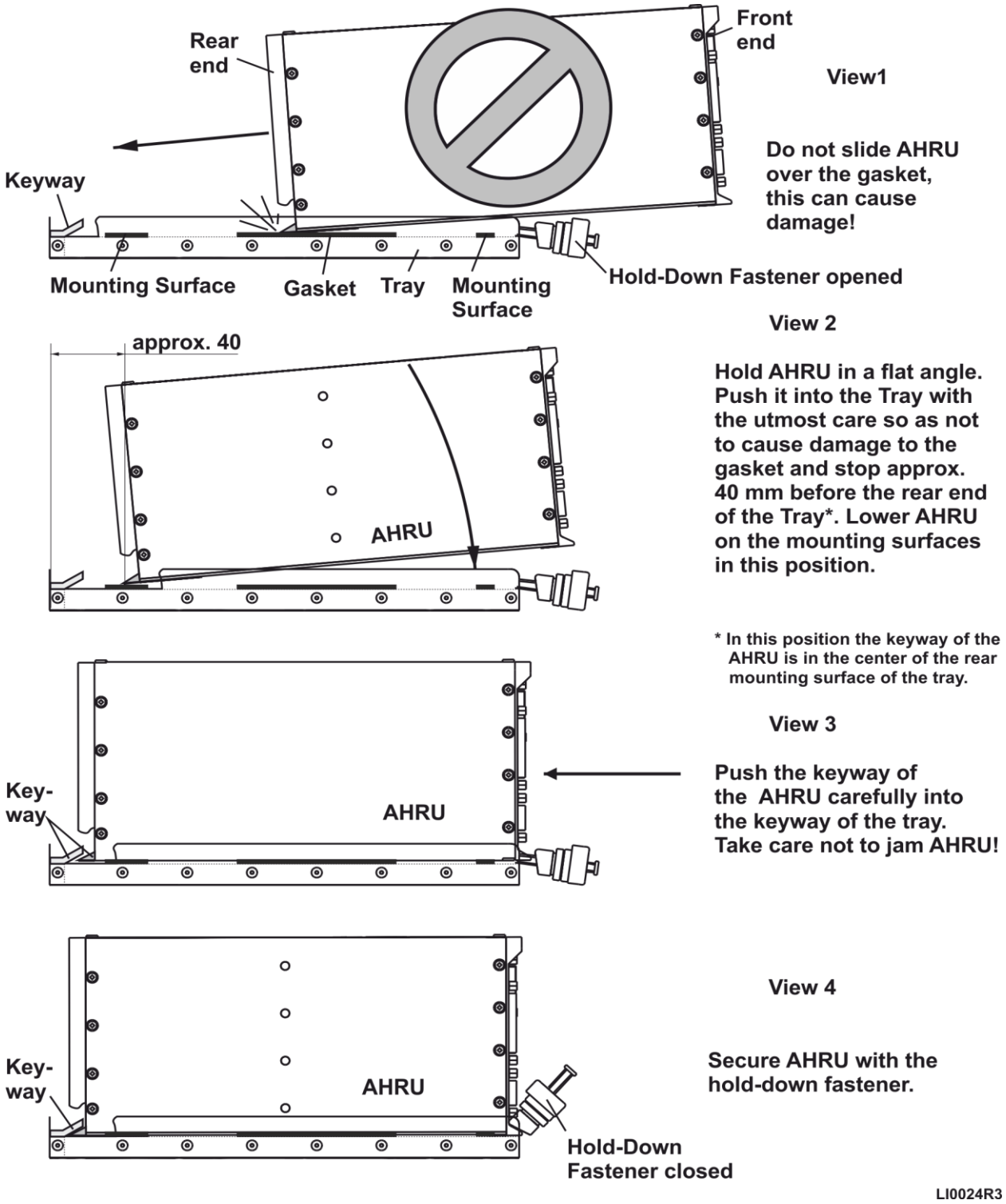

Rear end
Front end
View1
Keyway
Do not slide AHRU over the gasket, this can cause damage!
Mounting Surface
Gasket
Tray
Mounting Surface
Hold-Down Fastener opened
View 2
approx. 40
AHRU
Hold AHRU in a flat angle. Push it into the Tray with the utmost care so as not to cause damage to the gasket and stop approx. 40 mm before the rear end of the Tray*. Lower AHRU on the mounting surfaces in this position.
* In this position the keyway of the AHRU is in the center of the rear mounting surface of the tray.
View 3
Key-way
AHRU
Push the keyway of the AHRU carefully into the keyway of the tray. Take care not to jam AHRU!
View 4
Key-way
AHRU
Secure AHRU with the hold-down fastener.
Hold-Down Fastener closed
LI0024R3

Figure 4-2 Installation of the AHRU

3 Removal of the AHRU

For the following descriptions refer to Figure 4-3:

(1) Pull all AHRU-related circuit breakers out (off).

(2) Disconnect J1 through J6. (Leave IDM secured to the mounting tray by the retaining cable).

(3) **LCR-100 mounting tray:**
Loosen nut (wrench size 10 mm) and disengage hold-down fastener.

LCR-92/93 mounting tray:
Loosen self-torquing hold-down fastener securing AHRU in mounting tray by turning counterclockwise.

(4) Remove AHRU from the tray as shown in Figure 4-3.

(5) To avoid possible damage due to ESD install protective caps on the connectors immediately after removal of the AHRU from the mounting tray. Refer to section 5, paragraph 2.

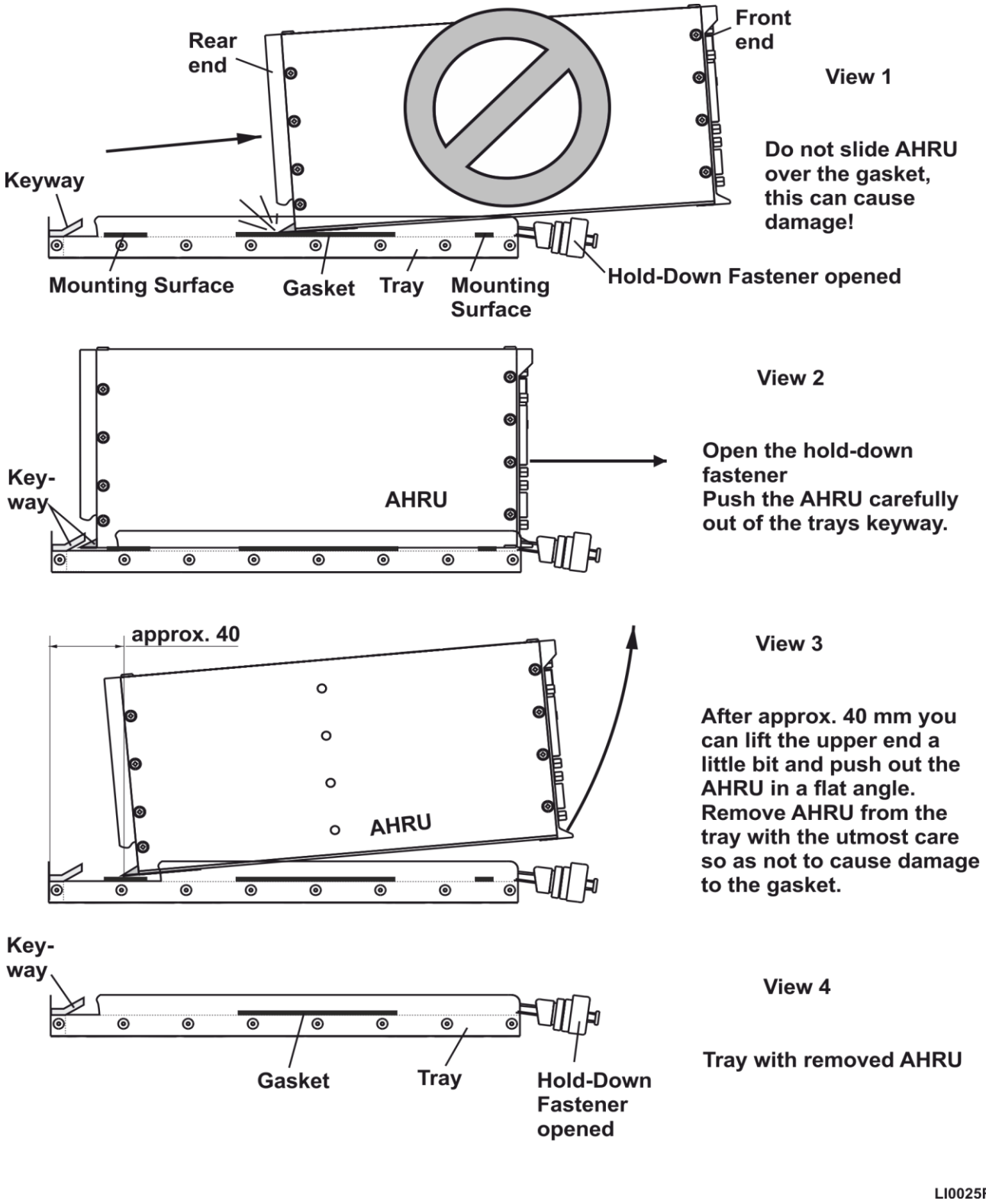


Figure 4-3 Removal of the AHRU

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SECTION 5

STORAGE/PACKAGING/TRANSPORTATION

1 General

This section provides storage, packaging and transportation procedures for the AHRU. The procedures contain recommended specifications, but their use is not mandatory.

CAUTION

Handle Units with care at all times. Mishandling could cause damage to sensitive components of the AHRU.

2 Protection of Connectors for Storage/Packaging and Transportation

This AHRU is sensitive to damage by electrostatic discharge. Please observe the following instructions. As a preparation for storage/packaging and/or transportation all connectors of the AHRU have to be protected by ESD/dust protection caps as shown in the following figure and table:

CAUTION

The use of other cover materials (e.g. tape) may lead to the loss of air worthiness.

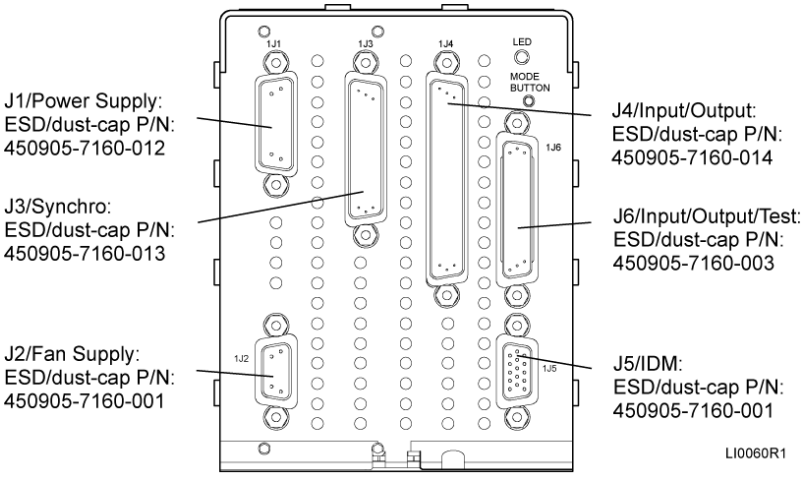


Figure 5-1 ESD/dust protection caps

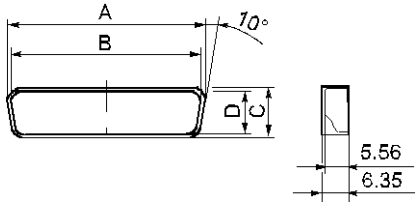
Drawing ESD/dust-cap	P/N	A	B	C	D	Connector size
	450905-7160-001	17.6	15.9	9.2	7.5	DE 9S
	450905-7160-003	39.7	38.0	9.2	7.5	DB 25S
	450905-7160-012	27.4	25.7	10.5	8.8	DA 15P
	450905-7160-013	41.5	39.8	10.9	9.2	DB 25P
	450905-7160-014	57.9	56.3	10.9	9.2	DC 37P
	Caps according MIL-C-24308; color black; conductive plastic.					

Table 5-1 ESD/dust protection caps

CAUTION

Do not remove the protective caps from the AHRU connectors unless installation or testing or maintenance is required. The caps protect the AHRU from possible damages. ESD damage may occur by bodily contact with one or more connector pins.

3 Storage

For storage - in particular for long term storage - we recommend to store the item under the following listed conditions which have generally proven for the storage of electronic-devices, -components and -parts:

- Temperature: preferably a constant Temperature between -40°C and +15°C
- Humidity: between 30% rH and 70% rH
- Reduced-emission atmosphere and package (no outgassing packaging materials)
- Protection against (UV-) Light
- Protection against dust
- ESD-Protection
- Protection against mechanical stress (e.g. shock, vibration)

4 Packaging/Transportation (References in accordance with ATA 300)

We recommend to ship the LCR-100 AHRU in containers according with ATA 300. This requirement is specified because of the need to protect the item through shipment, handling, and storage up to the moment of installation, and to repeat the cycle for the life of the item.

For the purpose of this specification, reusable shipping containers are designated as follows:

- Category 1 Reusable for a minimum of 100 round-trips
- Category 2 Reusable for a minimum of 10 round-trips
- Category 3 (1) Reusable for a minimum of 1 round-trip

1) applicable to LCR-100

The above categories are differentiated by materials used in the container construction and tests described in specification ATA 300.

Shock sensitivity of packaged AHRU according ATA 300 Rev. 2006 1, category II

Magnetic field sensitivity: N/A

Hazardous materials: N/A

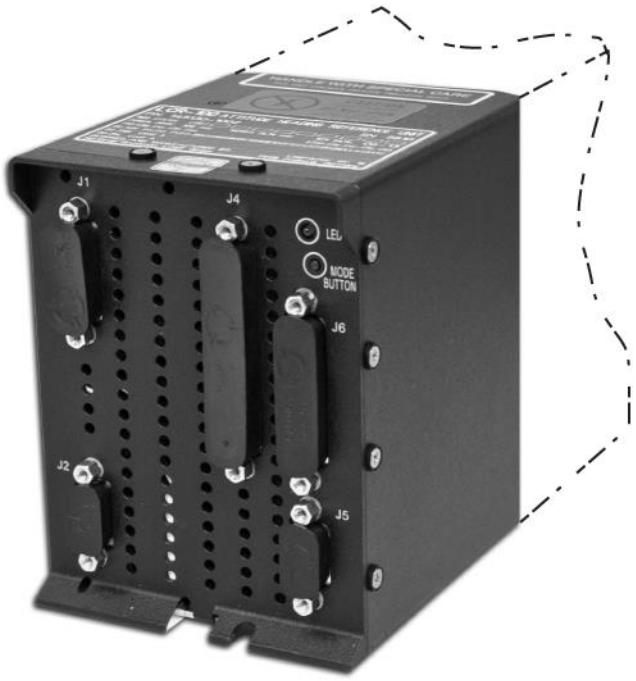
Electrostatic discharge sensitivity: refer to section 5, paragraph 2.

AHRU-size unpacked: refer to section 1, paragraph 8.1.1.

AHRU weight unpacked: refer to section 1, paragraph: 1.3.

The manufacturer ships the AHRU using a reusable container according ATA 300 Category 3. The following photos show as an example how the AHRU is packaged at the manufacturer.

Preparation of AHRU:

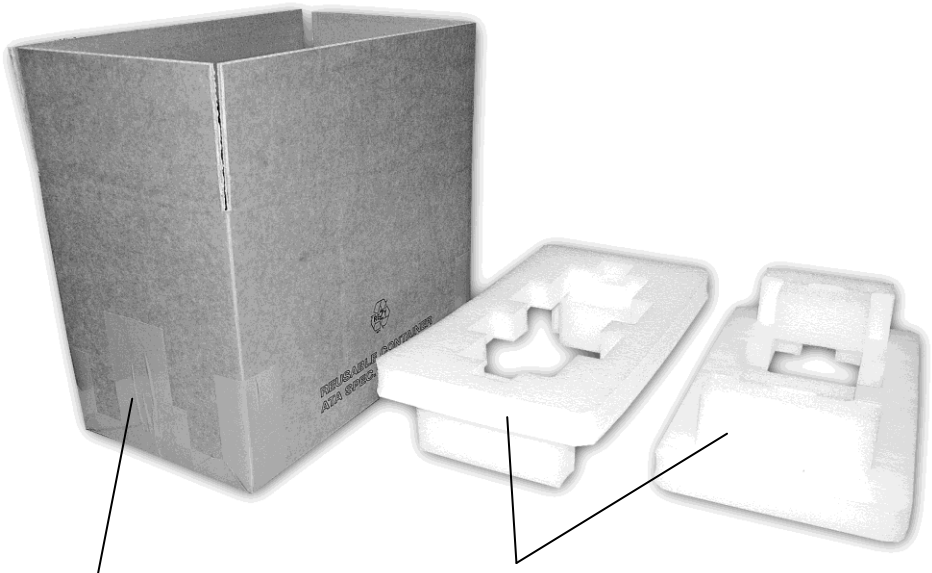


Protect the AHRU connectors with ESD/Dust protection caps
(refer to section 5, paragraph 2)

CAUTION

The use of other cover materials (e.g. tape) may lead to the loss of air worthiness.

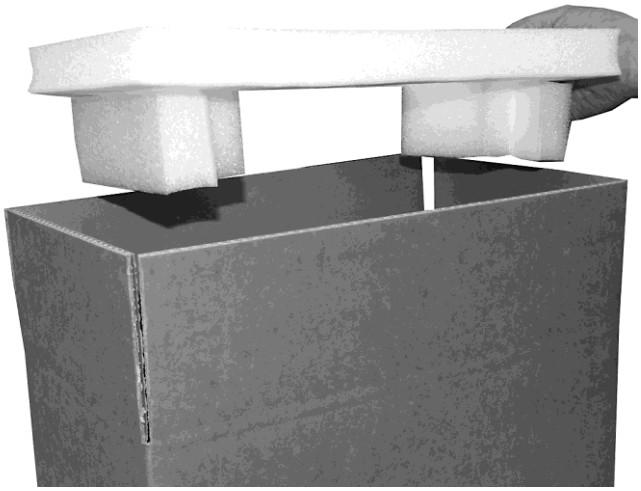
Used container:



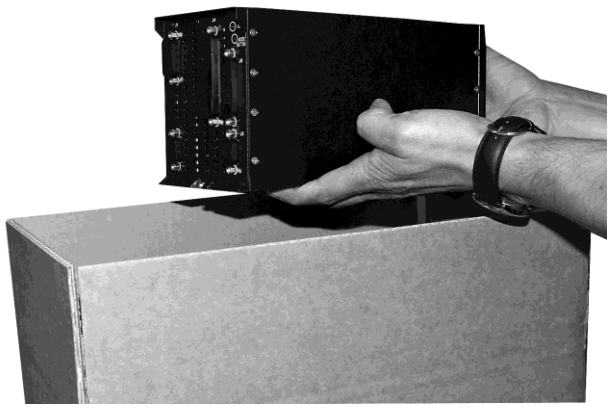
container:
P/N: 450911-0520-000

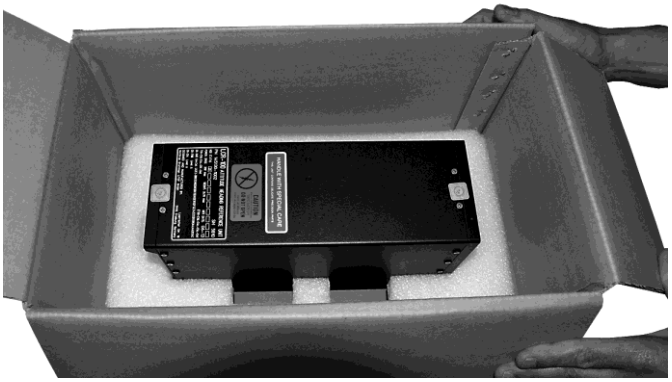
foam material:
P/N: 450911-0519-000 (2 pcs. required)

Packaging sequence:

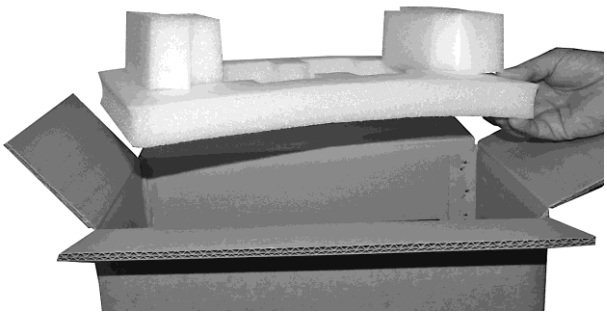


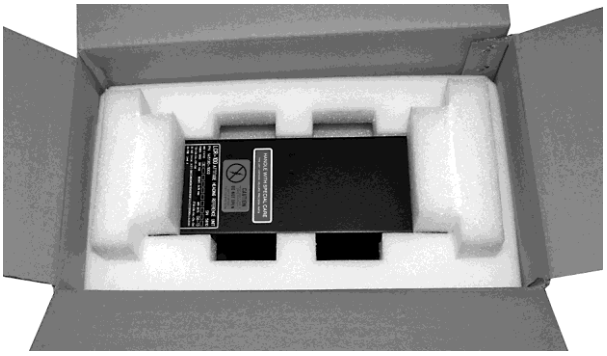
Insert the first foam as shown in the photo above



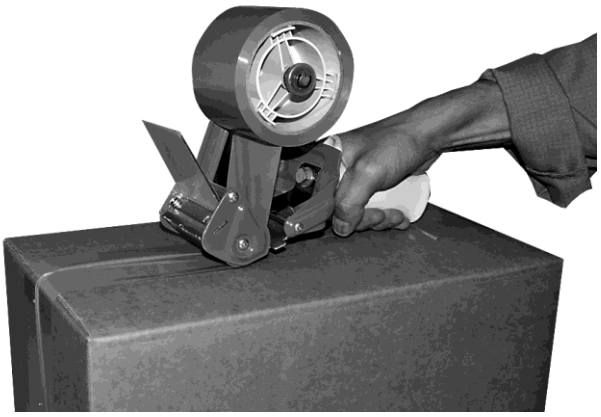


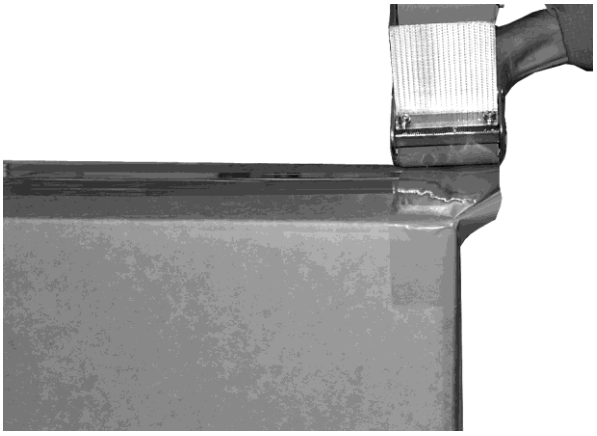
Insert the AHRU inside the container as shown in the photos above





Insert the second foam as shown in the photos above





Close the container at the top and at the sides using a commercial packing tape as shown in the photos above

Labeling:

Label it with a red Caution label similar as shown in the photo above

Size and weight

Size of closed AHRU container P/N: 450911-0520-000: 395 x 219 x 247 mm

Weight empty AHRU container P/N 450911-0520-000 with 2 pcs.
foam P/N 450911-0519-000: approx.: 860 g.

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Northrop Grumman LITEF GmbH

INSTALLATION/MAINTENANCE INSTRUCTION 145130-xxxx – LCR-100

REPORT OF POSSIBLE DATA ERROR

To help us upgrading the quality of our publications, Northrop Grumman LITEF GmbH encourages any report of a possible data error that will improve future editions of this publication.

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☐ **OEM** ☐ **Dealer** ☐ **End-User** ☐ **Other (Please specify)** _____

Your Name (optional)		**Company Name**	
Street Address		**City, State (Province), Zip Code, Country**	
Telephone No.		**FAX No.**	

POSSIBLE DATA ERROR

Section	Page No	Paragraph	Figure No.	Table No.	Description of Possible Data Error

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